WOMEN, CHEMICALS AND THE SDGs

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GENDER REVIEW MAPPING WITH A FOCUS ON WOMEN AND CHEMICALS:

IMPACT OF EMERGING POLICY ISSUES AND THE RELEVANCE FOR THE SUSTAINABLE DEVELOPMENT GOALS

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IPEN (International Pollutants Elimination Network) is a network of non-governmental organizations working in more than 100 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals.

www.ipen.org

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ABBREVIATIONS

BPA	Bisphenol A
BRS Conventions	Basel, Rotterdam and Stockholm Conventions
ECOSOC	United Nations Economic and Social Council
EDC	Endocrine-disrupting chemicals
EPI	Emerging Policy Issues and Issues of Concern
EPPPs	Environmentally Persistent Pharmaceutical Pollutants
EU	European Union
GEF	Global Environment Facility
GHS	Globally Harmonized System on Classification and Labelling of Chemicals
HHP	Highly Hazardous Pesticide
HSLEEP	Hazardous Substances within the Life Cycle of Electrical and Electronic Products
ICCM	International Conference on Chemicals Management
IHME	Institute for Health Metrics and Evaluation
ILO	International Labour Organization
MEA	Multilateral Environmental Agreements
OECD	Organisation for Economic Co-operation and Development
OEWG	Open-Ended Working Group
OPS	Overarching Policy Strategy
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PFAS	Per- and Polyfluoroalkyl Substances
POP	Persistent Organic Pollutant
PPE	Personal Protective Equipment
ROHS	Restriction of Hazardous Substances
SAICM	Strategic Approach to International Chemicals Management
SDG	Sustainable Development Goal
UNEP	United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organization

KEY FINDINGS: GENDER AND CHEMICALS

All people, irrespective of gender identity, must have the same rights, responsibilities and opportunities in order to achieve the sound management of chemicals and wastes, and both are vital to achieve the majority of the 2030 Sustainable Development Goals.

In order to identify and address inequalities, data that enable identification of impacts based on gender, i.e. the social attributes and opportunities associated with being male or female, and the biological sex is needed.

Women are generally more disproportionally impacted by exposure to chemicals and wastes and have less access to participation in decision making. Women are also key agents of change. Women and chemicals is an underexplored topic that deserves more attention.

Looking through the lens of the SAICM Emerging Policy Issues and Issues of Concern, a range of inequalities can be identified. Examples of these include:

Impacts throughout the product lifecycle

- In production: where women are, for example, highly exposed to hazardous chemicals during the production of electronics.
- During use: where women are exposed to chemicals that have especially detrimental impacts on pregnant women and developing children, such as lead in paint and chemicals in toys.
- After use and by end of product life: for example, where women are exposed to highly hazardous pesticides when gathering crops or cleaning used pesticide containers.

Disproportionate exposures based on gender roles

- In some countries, men conduct the manual labor such as collecting the electronic waste, but the women become exposed to the hazardous chemicals when extracting the valuable metals in the devices.
- Men and women are impacted differently, such as by perfluorinated chemicals and other endocrine-disrupting chemicals, where women can suffer impacts on reproductive and pregnancy outcomes even long after exposure.

Lack of information about impacts on women

- Little information is available about gender- or sex-dependent effects of pharmaceuticals in the environment or nanomaterials despite their ubiquitous use.

A range of activities at all levels can be considered, including:

- Strengthening the link between sound management of chemicals and waste and gender, including the important aspect of women and chemicals, in the SAICM Beyond 2020 process.
- Additional analysis of the global burden of disease related to women and chemicals and the integral role of women and chemicals in the sound management of chemicals and waste.
- Efforts are needed to ensure "women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life".

FOREWORD

We live in a world where chemicals are an essential part of our everyday life. They make our lives easier, but in doing so they also can pose a threat to human health and the environment. People of different genders can be affected differently by the exposure to chemicals and waste. Not only may exposure scenarios be diverse depending on factors related to gender and associated roles in life and work, the impact of exposure may be different contingent on the biological sex.

The corona pandemic once again reminds us of how our societies and economies depend on everybody's health, everywhere.

That is precisely why it is crucial to improve chemicals safety and to protect human health and the environment at national and international levels.

This is all the more important as according to the Global Chemicals Outlook II production in the chemicals sector is expected to almost double by 2030.

In July 2021, the fifth International Conference on Chemicals Management (ICCM5) in Bonn will decide about the chemicals and waste management after 2020. Designing the Strategic Approach to International Chemicals Management (SAICM) beyond 2020 offers the unique opportunity to set the course for an ambitious, gender-responsive chemicals management that meets the different needs, vulnerabilities and social roles of people of different genders and at the same time helps to deploy everybody's contributions to the sound management of chemicals and waste.

Nevertheless, both gender expertise and more research as well as continuing action are needed to raise awareness among all relevant stakeholders and the general public of the importance of ambitious chemicals and waste management.

In my view it is vital that we use the potential of gender mainstreaming to make our work in the field of chemicals and waste more comprehensive, more impactful and more sustainable. Providing everyone with equal rights, opportunities and responsibilities in decision-making is not only a human rights issue, it is key to achieving the 2030 Sustainable Development Goals.

It seems evident that we do need enhanced and joined-up thinking of sustainable development, environmental protection, the sound management of chemicals and waste and gender justice in the future.

I hope this report will encourage further action towards gender equality and the empowerment of women within SAICM beyond 2020.

Gertrud Sahler

President,
5th International Conference on Chemicals Management (ICCM5)

1. INTRODUCTION: CONTEXT AND AIM OF THE REPORT

The Strategic Approach to International Chemicals Management (SAICM) is a multi-stakeholder and multi-sectoral policy framework adopted in 2006 to promote chemical safety around the world. Its overall objective is the achievement of the sound management of chemicals throughout their life cycle so that by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health, supporting the 2020 goal agreed at the 2002 Johannesburg World Summit on Sustainable Development.[1] As of March 2020, 180 of the 193 UN Member States had identified SAICM Focal Points. SAICM is supported by the SAICM Bureau that advises the SAICM President and the SAICM Secretariat hosted by the UN Environment Programme (UNEP) on the conduct of the business of the Conference and its subsidiary bodies.

In 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) that can serve as the blueprint to achieve a better and more sustainable future for all.[2] Each goal is further defined by a list of targets to ensure progress can be assessed. While there is no separate goal to achieve sound management of chemicals and wastes, this is essential for reaching most of the goals, for example Zero Hunger (Goal 2), Clean Water and Sanitation (Goal 6), and Responsible Consumption and Production Patterns (Goal 12). Gender Equality is a separate goal (Goal 5) but is also a prerequisite for reaching most of the other goals.

In 2018, the Global Environment Facility approved the project Global Best Practices on Emerging Chemical Policy Issues of Concern under the Strategic Approach to International Chemicals Management (SAICM).*

* http://www.saicm.org/Implementation/GEFProject/tabid/7893/language/en-US/Default.aspx

The project aims to accelerate the adoption of national and value chain initiatives to control Emerging Policy Issues (EPIs) and contribute to the 2020 SAICM goal and the 2030 Agenda for Sustainable Development. UNEP is the Implementing Agency of the project, with the SAICM Secretariat as Executing Agency.

The project has three Components:

- Promoting regulatory and voluntary action by government and industry to phase out lead in paint
- Lifecycle management of chemicals present in products, and
- Knowledge management and stakeholder engagement.

The report is an Output of Component 3 on knowledge management and stakeholder engagement. The component will develop a SAICM Knowledge Management Platform (www.saicmknowledge.org) that is the repository of information for the sound management of chemicals, and a knowledge hub, where countries and other stakeholders can access up-to-date information, and join communities of practices for peer-to-peer learning exchanges.

The International Pollutants Elimination Network (IPEN) is a global network of public interest NGOs founded in 1998, working together for a world in which toxic chemicals are no longer produced or used in ways that harm human health and the environment. IPEN represents public interest organizations on the SAICM Bureau and is an Executing Partner of the project's Lead Paint Elimination Component.* In December 2017, UNEP and IPEN signed a Memorandum of Understanding to partner in the work on Gender and Chemicals through a focus on women in the following areas:

- Raising awareness of the impact to women and children as vulnerable populations to the health effects linked to chemical exposures, including creating opportunities for training and experience sharing and collecting relevant sex disaggregated data.
- Promoting women's engagement and leadership in decision-making processes at local, national and global levels.
- Implementing and contributing to activities related to SAICM Emerging Policy Issues and other Issues of Concern as well as related chemicals conventions and relevant Sustainable Development Goals.

* https://ipen.org/

Sustainable development, environmental protection and the sound management of chemicals and waste are all interlinked. Therefore, in order to achieve the 2030 Sustainable Development Goals (SDGs), it is important to consider how different groups may be differently impacted by hazardous chemicals e.g. due to social context, economic status, physiology, or occupational inequalities. When adopting SAICM, governments recognized the need to make special efforts to protect groups that are either particularly vulnerable to risks from hazardous chemicals or are highly exposed to them. These include, among others, women, children, illiterate people, informal and illegal workers who all face inequalities related to the impact of chemicals.

Therefore, in line with the UNEP-IPEN partnership, the aim of this report is to show the impact chemicals have on women as a vulnerable group highly exposed to hazardous chemicals and gender inequalities related to decision-making around the management of chemicals and waste. The report also means to provide concrete steps that can be taken to safeguard the health of women and empower women in decision-making and in their roles as agents of change. The overall objective is to provide evidence to all stakeholders working towards sustainable development of the importance of addressing this issue for achieving the 2030 Sustainable Development Goals.

2. DIMENSIONS OF GENDER INEQUALITIES IN THE FIELD OF CHEMICALS AND WASTE

DEFINITIONS

The word gender is used in many contexts and with different meanings. In this report, the term gender is used as defined by the Office of the Special Advisor on Gender Issues and Advancement of Women (now UN Women):

> *"... the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context/ time-specific and changeable. Gender determines what is expected, allowed and valued in a woman or a man in a given context. In most societies there are differences and inequalities between women and men in responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities. Gender is part of the broader socio-cultural context."*[3]

The World Health Organization (WHO) includes some additional aspects of the term gender:

> *"Gender refers to the socially constructed norms, roles and relations of and among women, men, boys and girls. Gender also refers to expressions and identities of women, men, boys, girls and gender-diverse people. Gender is inextricable from other social and*

structural determinants shaping health and equity, and can vary across time and place".[4]

A further dimension of gender is provided by the International Labour Organization (ILO):

> *"Changes in gender roles often occur in response to changing economic, natural or political circumstances including development efforts or structural adjustment, or other nationally or internationally based forces. The gender roles within a given social context may be flexible or rigid, similar or different, and complementary or conflicting. Both women and men are involved to differing degrees and in different ways in reproductive, productive and community management activities and play roles within social and political groups. Their involvement in each activity reflects the gender division of labour in a particular place at a particular time. The gender division of labour must be reflected in gender analysis. Gender relations have an effect on every aspect of employment, working conditions, social protection, representation and voice at work; this is why gender is called a cross-cutting issue in the world of work".*[5]

The General Conference of ILO has therefore adopted two Conventions directly addressing the issue of gender equality and labor:

C100 - Equal Remuneration Convention, 1951 that commits Members to *"...ensure the application to all workers of the principle of equal remuneration for men and women workers for work of equal value"*;[*] and

C111 - Discrimination (Employment and Occupation) Convention, 1958, that requires Members *"... to declare and pursue a national policy designed to promote, by methods appropriate to national conditions and practice, equality of opportunity and treatment in respect of employment and occupation, with a view to eliminating any discrimination in respect thereof".*[**]

Noting the potentially different impacts and effects of chemicals related to biological factors such as physiology and endocrine systems, it is also important to consider the biological sex in relation to the environmentally sound management of chemicals and waste. The definition of biological sex by the World Health Organization is used in this report:

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* https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C100

** https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C111

"Sex refers to the biological characteristics that define humans as female or male. These sets of biological characteristics are not mutually exclusive, because there are individuals who are born with physical or biological sex characteristics who do not fit the traditional definitions of female or male (intersex). Sex differences can be observed at the level of chromosomes, gene expression, hormones, immune system and anatomy (e.g. body size, and sexual and reproductive anatomy)".[4]

It is important to note that the gender identity of an individual may or may not correspond with the biological sex assigned, and that it should rather be understood as the individual, personal experience of gender. Gender identity exists on a spectrum and is not necessarily confined to an identity that is completely male or completely female.[6]

IDENTIFYING GENDER INEQUALITIES: THE NEED FOR GENDER-DISAGGREGATED INFORMATION

Gender equality means that women and men have the same rights, responsibilities and opportunities in all areas of life. This includes quantifiable aspects such as equal gender distributions in various contexts, but also underlying dimensions such as attitudes, norms, values and ideals that impact the lives of women and men in all areas of life.

Promoting women's rights is at the core of the United Nations, as stated in Article one of its Charter:

"The Purposes of the United Nations are ... promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion."

In line with this, the UN Economic and Social Council established a Commission on the Status of Women* already in 1946, i.e. within the first year of its existence. This is the principal global intergovernmental body exclusively dedicated to the promotion of gender equality and the empowerment of women. The Commission reaffirmed the close connection between gender equality and human rights by ensuring gender neutral language in the 1948 Universal Declaration of Human Rights, stating that:

"All human beings are born free and equal in dignity and rights," and that "everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, colour, sex, language, religion, ... birth or other status."

One more important aspect of gender equality as highlighted by UN Women is that it does not mean that women and men will become the same, but that equality means that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. They also state that:

"Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration – recognizing the diversity of different groups of women and men. Gender equality is not a 'women's issue' but should concern and fully engage men as well as women. Equality between women and men is seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centered development".[3]

It is therefore important to have access to both gender- and sex-disaggregated data, i.e. data and information collected that records responses separately for women and men and presents the results in a way that makes it possible to identify differences between these two groups. When analyzing issues related to gender equality in the workforce, gender-disaggregated data could for example include the percentage of the workforce that identify as male/female and their salary levels, whereas sex-disaggregated data would focus on the sex-specific differences in e.g. impact of chemical exposure at the workplace. Only when both types of data are available can progress towards gender equality be tracked and evaluated.

* https://www.unwomen.org/en/csw

However, gender-disaggregated data in labor statistics is unfortunately often lacking for occupational exposure to hazardous chemicals. This lack of data makes occupational epidemiology challenging in many cases. Therefore, ILO has developed Guidelines for Gender Mainstreaming in Occupational Safety and Health, explaining how gender issues can be integrated into analyses, formulation and monitoring of policies, programs and preventive measures in order to reduce inequalities between men and women. Key approaches include Guideline 5 on Developing gender-sensitive OSH indicators based on sex-disaggregated data, Guideline 3 on Ensuring consideration of gender differences in risk management, and Guideline 9 on Designing work equipment, tools and personal protective equipment for both men and women.[7]

"ALL HUMAN BEINGS ARE BORN FREE AND EQUAL IN DIGNITY AND RIGHTS" AND THAT "EVERYONE IS ENTITLED TO ALL THE RIGHTS AND FREEDOMS SET FORTH IN THIS DECLARATION, WITHOUT DISTINCTION OF ANY KIND, SUCH AS RACE, COLOUR, SEX, LANGUAGE, RELIGION, … BIRTH OR OTHER STATUS."

Gender inequality and the need for gender-disaggregated data has also been acknowledged in relation to environmental impact, such as in the Convention on Biological Diversity[8], the Beijing Platform for Action[9] and in the Global Environment Outlook.[10] However, a 2015 report by the International Union for Conservation of Nature's (IUCN) Global Gender Office (GGO) concluded that there is a lack of sex-disaggregated data throughout environmental sectors globally.[11]

In 2016 UNEP and partners released The Global Gender and Environment Outlook in response to a call from the Network of Women Ministers and Leaders for the Environment in 2012. This provides a thorough overview of current knowledge on gender and the environment, the linkages between gender and environment in the contexts of SDGs and the 2030 Development agenda, and proposes actions for a more sustainable future that position women and men as equal agents. Actions especially relevant for the sound management of chemicals and waste include the integration of gender into national action plans, monitoring and reporting systems; enabling gender-sensitive financing mechanisms under multilateral environmental agreements such as the Basel, Stockholm and Rotterdam Conventions; and the promotion and support of women's voices, leadership and organization.[12]

GENDER MAINSTREAMING AS A TOOL FOR PROMOTING GENDER EQUALITY

In order to promote gender equality, the concept of gender mainstreaming has been widely integrated into the work of UN Agencies, by governments and by funding agencies such as the Global Environment Facility. While not a goal in itself, it is an approach by which gender equality can be promoted for example in research, legislation, policy development and in activities on the ground. It is also utilized to ensure that women as well as men can influence, participate in and benefit from development efforts. However, the strategy must be complemented by targeted efforts to promote gender equality and women's empowerment, for example where there is persistent discrimination of women and vast gaps in equality between women and men.

Gender mainstreaming has been defined by the United Nations Economic and Social Council (ECOSOC) as:

> *"a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of the policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The relative status of women and men, the interaction between gender and race, class and ethnicity, and questions of rights, control, ownership, power, and voice–all have a critical impact on the success and sustainability of every development intervention."*[13]

This means in practice a strategy leading to identification of gaps in gender equality supported by the use of sex-disaggregated data, that efforts are developed that aim to close those gaps, and that resources and expertise are allocated to implement these strategies. In order to achieve the sought-after results, it is very important to closely monitor the implementation of these strategies, evaluate progress and possible strategy adjustments, and holding individuals and institutions accountable.[14]

The efforts to promote gender mainstreaming have had a demonstrable effect. For example, the report of the Secretary-General to the UN General Assembly in 2019 on Women in development highlighted that Member States have reported that they are adjusting their national legal and policy frameworks to the gender-responsive implementation of the 2030 Agenda. It further described that 18 countries have defined gender equality plans and sought to mainstream gender perspectives in national policies and programmes.[15]

An important component of mainstreaming is gender-responsive budgeting that makes sure that the gender dimensions are considered at all stages of the budget cycle. This includes both analyzing the impact of the budget from a gender perspective and allocating resources to address gender inequalities.[16]

Gender mainstreaming has been implemented in the area of chemicals and waste, both in international organizations and at national level. The Global Environment Facility (GEF) notes that equality for women and girls is a strategic and operational imperative for the GEF, that gender inequality increases the negative effects of environmental degradation on women and girls, and has provided a set of guiding principles and mandatory requirements for Mainstreaming Gender across the GEF's governance and operations.[17]

In July 2012, the Executive Secretary of the Basel, Rotterdam and Stockholm (BRS) Conventions established a Gender Task Team within the BRS Secretariat to develop targets and an approach to gender mainstreaming within the BRS Secretariat. The resulting BRS Gender Action Plan was finalized in December 2013, and includes a vision, a list of expected short-, medium-, and long-term goals, and monitoring and reporting plans. This was updated in 2019 with indicators for monitoring.[18] This Action Plan has led to greater recognition of the links between gender and hazardous chemicals and wastes.

The UNDP has developed a training manual as support to its partners in their work on mainstreaming gender in national processes, including a module on the why and how of mainstreaming gender in chemicals management. A new module on Gender, Chemicals and Waste was recently made available.* Further details about policies and international chemical safety agreements with elements relevant for the issue of women and chemicals are provided below.

The goal of the ILO is to "*promote equal opportunities for women and men to obtain Decent Work*". The latter is defined as "*fairly paid productive work carried out in conditions of freedom, equity, security and human dignity*".** Its Action Plan for Gender Equality is a key tool for gender mainstreaming and reducing gender inequality in the world of work, with the aim to ensure that gender analysis and planning are introduced into all ILO activities, and at every level. In line with this and to ensure that both women and men are protected from chemical hazards, the ILO has adopted more than 50 legal instruments, including Conventions, their accompanying Recommendations, as well as Codes of Practice.[19]

DIFFERENTIATED EXPOSURE TO HAZARDOUS CHEMICALS

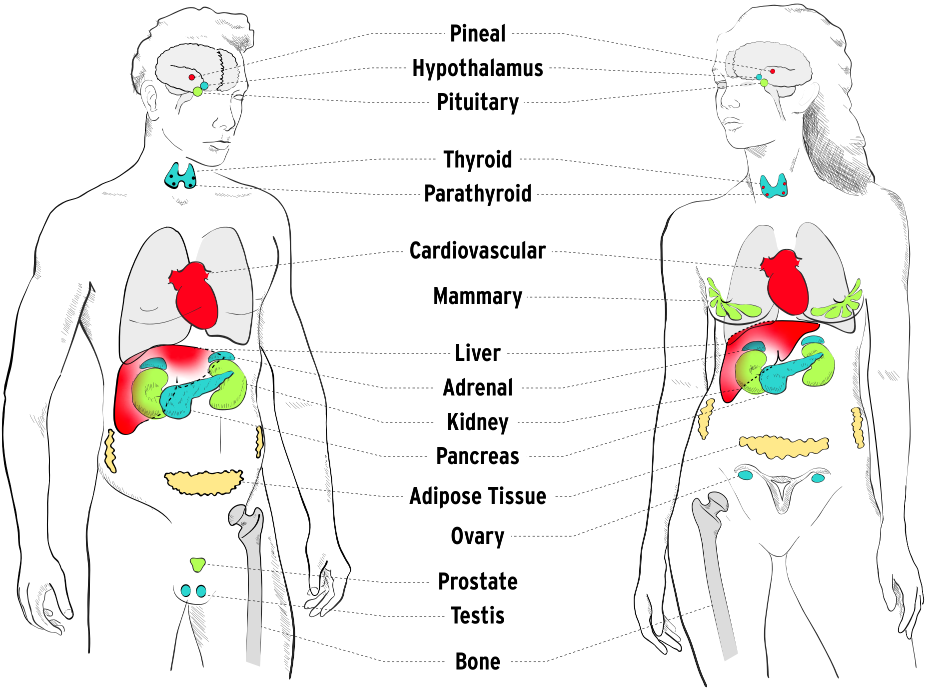
Impacts on human health from chemicals and waste are determined by social as well as biological factors. It is therefore important to gather both gender- and sex-disaggregated data in order to assess these impacts and develop strategies to prevent adverse health outcomes. Not only may exposure scenarios be different depending on factors related to gender, the impact of exposure may be different dependent on your biological sex.[14]

Sex-differentiated effects of exposure

Women and men vary in their susceptibility to exposure to toxic chemicals, and health effects vary based on biological factors such as size, body fat, hormonal levels, and differences in enzyme levels and activity. Women have in general a relatively higher proportion of body fat compared to men and are therefore likely to store more environmental pollutants that bioaccumulate in fat tissue, such as most persistent organic pollutants (POPs). Women may also have different susceptibility to hazardous chemicals in connection with their reproductive cycles and at different life stages such as pregnancy, lactation, and menopause, when their bodies undergo physiological changes that may affect their vulnerability to health damage from toxic chemicals.[14] There are also chemicals that impact pregnancies, harm

* https://www.uncclearn.org/news/new-module-gender-chemicals-and-waste-available-online

** https://www.ilo.org/gender/Aboutus/ILOandGenderEquality/lang--en/index.htm



fetuses and are transferred during breastfeeding that have implications especially for women.

A prominent biological difference between men and women is their endocrine systems. These consist of a number of glands that are distributed throughout the body of humans and other vertebrates. These glands produce and excrete hormones, i.e. signaling molecules, directly into the blood stream. Once the hormones reach their target receptor, they bind and produce a specific physiological response. Hormones typically act at very low concentrations in a non-linear way, i.e. the change in response is not necessarily directly proportional to a change in concentration. Hormones act differently at different times, which means that both timing and concentration of the specific hormone is important. There are chemicals that cause disturbances in the hormone system, so called endocrine-disrupting chemicals (EDCs), which can lead to different effects in men and women. For example, some chemicals affect male reproduction through lowering the sperm count, whereas others affect female reproduction through impact on pregnancy success. The endocrine-disrupting chemicals are addressed in more detail in chapter 3 below.

Sex-differentiated sensitivity to hazardous chemicals have implications for standardized risk assessment used by regulatory agencies to determine at what exposure level a chemical can be considered safe. Although there are differences in the way countries conduct risk assessment for chemicals, the approach typically utilizes safety factors to account for variations in sensitivity in the exposed population as well as exposure factors to account for different exposure scenarios, e.g. if the chemical is inhaled through household dust, ingested when eating contaminated food, or drinking contaminated drinking water. Factors for variation in sensitivity are typically not only expected to take sex-specific differences into account but is also expected to take e.g. toxicokinetics/metabolism, age, health status and nutritional status into account. It is also common practice to use standardized factors to extrapolate from short-term to long-term exposure, which also have sex-related implications e.g. since men and women may excrete chemicals at a different rate and hence, have a different long-term effect. By applying these factors to a no-effect level that is determined experimentally through standardized tests, an exposure level considered safe is derived.[20, 21] It should however be noted that this type of approach assumes that there is a defined threshold where a chemical does not have an effect and that the approach captures long-term effects from exposure during development. Since many EDCs do not have a safe threshold and cause a range of effects that are not usually assessed in standardized tests, there is increasing consideration for these types of chemicals and how to assess their risk to men and women.[22]

An emerging field of science is epigenetics, which studies the effects of the environment (including chemical exposure) affecting inherited physiological traits through altering genetic control by factors other than an individual's DNA sequence. For example, a study showed that death related to diabetes increased for children if food was plentiful during a critical period before puberty for the paternal grandfather, but it decreased when excess food was available to the father.[23] There is emerging evidence that these types of effects can be sex-specific[24] and this is likely an important future consideration for chemical risk assessment.

Gender-differentiated exposure

Levels, frequency and sources of exposure to hazardous chemicals can vary depending on gender-related differences. Gender differences include, for example, occupational roles of men and women as well as purchase and use patterns for certain products. Women are generally more exposed to hazardous chemicals in cosmetics than men[14], while men in manual labor, such as construction workers, are generally more frequently subjected to occupational exposure to hazardous chemicals.[25] Since women are gen-


erally responsible for most of the household work in many countries, they are exposed to chemicals in household products to a higher extent than men. Women are also more likely to do the shopping for food and household products than men. Both food and consumer products are sources of exposure to a variety of hazardous chemicals (as described in chapter 3).[26,27] In addition to regulatory controls limiting chemical trace levels, product labeling disclosing chemical additives and awareness-raising efforts would empower consumers to choose products safe for them and the whole household. However, care must be taken so that this does not add another level of inequality by disproportionately placing the responsibility for protecting the household on the women.

Also, there is often a difference in which types of occupations and work tasks women and men are assigned to, especially in more traditional societies, which leads to different work-related exposures and subsequent health effects.[28] In addition, even when women have the same or similar occupations as men, there are often differences in working conditions, which in turn influence work-related health risks.[29] A recent study on occupational gender differences in a range of economic sectors from Italy showed that not only was there gender segregation per occupation, women were also more likely to be exposed to high levels of carcinogens even when in the same occupation as men.[30] These gendered differences in exposure have been shown both in highly industrialized countries such as the European Union[29] as well as in developing countries as discussed further in chapter 3. The ILO Convention on equal remuneration for work

of equal value is highly relevant in this context.* This provides the basis for assessing the risk of occupational exposure to hazardous chemicals and associated impacts different for women and men, and for providing fair and non-discriminatory remuneration.

Gender considerations have therefore implications for occupational exposure to hazardous chemicals and should be reflected in occupational exposure standards. However, many occupational studies fail to take gender differences into account. The WHO notes that many studies are conducted either without women or that the gender of the participants is not recorded at all. It also notes that studies are prone to correct for gender rather than to consider gender- and sex-specific factors in the design and evaluation of studies.[31]

To address exposure in the various roles played by women, the ILO concludes that it is important to take all areas of life of working women into account, including their roles as housewives and mothers, in order to be able to formulate effective health promotion policies.[32] The ILO states that "*Women workers are particularly disadvantaged by out of date workforce structures, workplace arrangements and attitudes*" and that "*General measures directed at all workers do not necessarily achieve the desired benefits for women workers*".**

* https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C100

** https://www.ilo.org/global/about-the-ilo/how-the-ilo-works/departments-and-offices/governance/labadmin-osh/news/WCMS_329109/lang--en/index.htm

ILO also recommends that gender differences should be considered in the development of occupational safety and health policies and prevention strategies. It has developed guidance on gender and occupational safety, on special consideration for women workers as well as several labor standards addressing the issue.*

PARTICIPATION OF WOMEN IN DECISION-MAKING RELATED TO THE SOUND MANAGEMENT OF CHEMICALS AND WASTE

Women have more limited decision-making power at all levels in most countries and communities worldwide, ranging from the low number of parliament seats and higher-level government positions held by women, to decision-making at the household level.** Women are also less likely to hold decision-making positions in the private sector. This means that women are less likely to be involved in decision-making in relation to hazardous chemicals in the manufacturing industry and other enterprises.[33] Women are also less likely to be unionized than men[34] and less likely to participate in occupational health and safety committees[35], which may lead to less consideration of working conditions for women.

Despite the fact that women play a major role in managing natural resources and often contribute significantly as household providers e.g. in the agricultural sector, environmental decision-making bodies and leadership positions at all levels are often dominated by men.[11] As a consequence, women's perspectives often go unrecognized and their needs are not met in environmental policies. This undermines the development of gender-responsive policies. However, with their wealth of expertise and extensive experience, women also act as key agents of change in all sectors of society.

The GEF notes that women and men continue to be constrained to participate in, contribute to and benefit from environmental projects and programs due to unequal decision-making despite recent efforts to promote gender equality. However, a recent evaluation also acknowledges progress both in relation to gender considerations in GEF-funded projects as well as in decisions under the multilateral environmental agreements (MEAs) that the GEF serves. The latter includes calls for specific action by Convention Parties to ensure that women's participation and empowerment is addressed when pursuing the objectives of the MEAs.[17]

A key element of gender equality in relation to the sound management of chemicals and waste is equal participation in decision-making at all levels.

* https://www.ilo.org/safework/areasofwork/gender-and-occupational-safety-and-health/lang--en/index.htm
** https://www.oecd.org/gender/data/

However, as recognized in the UNEP Statement on Gender and the Environment, "...*although progress on gender equality has been made in some areas, the potential of women to engage in, contribute to and benefit from sustainable development as leaders, participants and agents of change has not been fully realized...*" This includes full and equal participation in decision-making and management at all levels.[36]

In 2015, an evaluation was made of women's participation and gender considerations in countries' representation, planning and reporting to the BRS Conventions. This concluded that while 91% of the initial Stockholm Convention National Implementation Plans (NIPs) contained women and/or gender keywords, this was in a majority of cases in relation to women as a vulnerable group. Only 35% of the NIPs identify women as stakeholders and only 8% consider women's engagement and gender considerations as an objective.[37]

In the SAICM Overarching Policy Strategy (OPS) the specific importance of women as stakeholders is emphasized. It is also acknowledged that women still do not participate in all aspects of decision-making related to the sound management of chemicals and that this is a situation that needs to be addressed.[1] In the SAICM independent evaluation of activities from 2006-2015, certain gender aspects were included.[38] In line with the objective of the evaluation, these should be taken into consideration and guide stakeholders in future arrangements for the Strategic Approach and the sound management of chemicals and waste beyond 2020:

- A weakness of the SAICM Quick Start Projects was that gender was only addressed in a minority of these projects. The projects that included gender were typically those that were implemented by non-governmental organizations.
- In relation to risk reduction activities, the specific vulnerability of female workers was highlighted due to the relatively high numbers of female workers that are found in manufacturing, agriculture, services and the informal sector.
- When assessing the progress of SAICM, gender-specific impacts were highlighted and that the burden of disease and disability attributable to chemicals exposure is not equally apportioned across countries, gender or age groups.

BRIEF OVERVIEW OF POLICIES AND INTERNATIONAL CHEMICAL SAFETY AGREEMENTS WITH ELEMENTS RELEVANT FOR THE ISSUE OF WOMEN AND CHEMICALS

In addition to the agreements and statements mentioned already, several international agreements specifically link women's issues to environmental management in general and chemical safety in particular.

The 1992 Rio Declaration on Environment and Development states in its Principle 20 that "Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development."[39]

The Stockholm Convention preamble notes, *"health concerns, especially in developing countries, resulting from local exposure to persistent organic pollutants, in particular impacts upon women and, through them, upon future generations."*[9] The treaty obligates governments to, *"consult their national stakeholders, including women's groups and groups involved in the health of children, in order to facilitate the development, implementation and updating of their implementation plans."*[10] The Stockholm Convention instructs Parties to promote and facilitate, *"Development and implementation, especially for women, children and the least educated, of educational and public awareness programmes on persistent organic pollutants, as well as on their health and environmental effects and on their alternatives."*[11]

While the text of neither the Basel nor the Rotterdam Convention mentions gender or women, these are both included in the objectives and actions of the Gender Action Plan developed by the BRS Secretariat.

The Minamata Convention on Mercury preamble notes awareness of "*... health concerns, especially in developing countries, resulting from exposure to mercury of vulnerable populations, especially women, children, and, through them, future generations.*"[12] National Action Plans to address artisanal and small- scale gold mining include, *"Strategies to prevent the exposure of vulnerable populations, particularly children and women of child-bearing age, especially pregnant women, to mercury used in artisanal and small-scale gold mining."*[13]

The 2017 Global Environment Facility (GEF) policy on gender equality includes a range of requirements to "*...ensure equal opportunities for women and men to participate in, contribute to and benefit from GEF-Financed Activities in support of the GEF's efforts to achieve global environment benefits*". This includes mandatory requirements on gender considerations in the design, monitoring and evaluation of projects, in addition to ensuring that agencies have the necessary gender-related policies, procedures and capabilities in place.

SAICM includes important aspects related to women that intimately links chemical safety with sustainable development. The SAICM Dubai Declaration commits governments to, "*work towards effective and efficient governance of chemicals management by means of transparency, public participation and accountability involving all sectors of society, in particular striving for the equal participation of women in chemicals management.*" SAICM's Overarching Policy Strategy notes that "*in many countries some stakeholders, particularly women and indigenous communities, still do not participate in all aspects of decision-making related to the sound management of chemicals, a situation which needs to be addressed"* and states the importance of public participation in decision-making, *"featuring in particular a strengthened role for women."* Risk reduction measures need to be improved, "*to prevent the adverse effects of chemicals on the health of children, pregnant women, fertile populations, the elderly, the poor, workers and other vulnerable groups and susceptible environments."* Finally, one of SAICM's objectives is "*To ensure equal participation of women in decision-making on chemicals policy and management.*"[40]

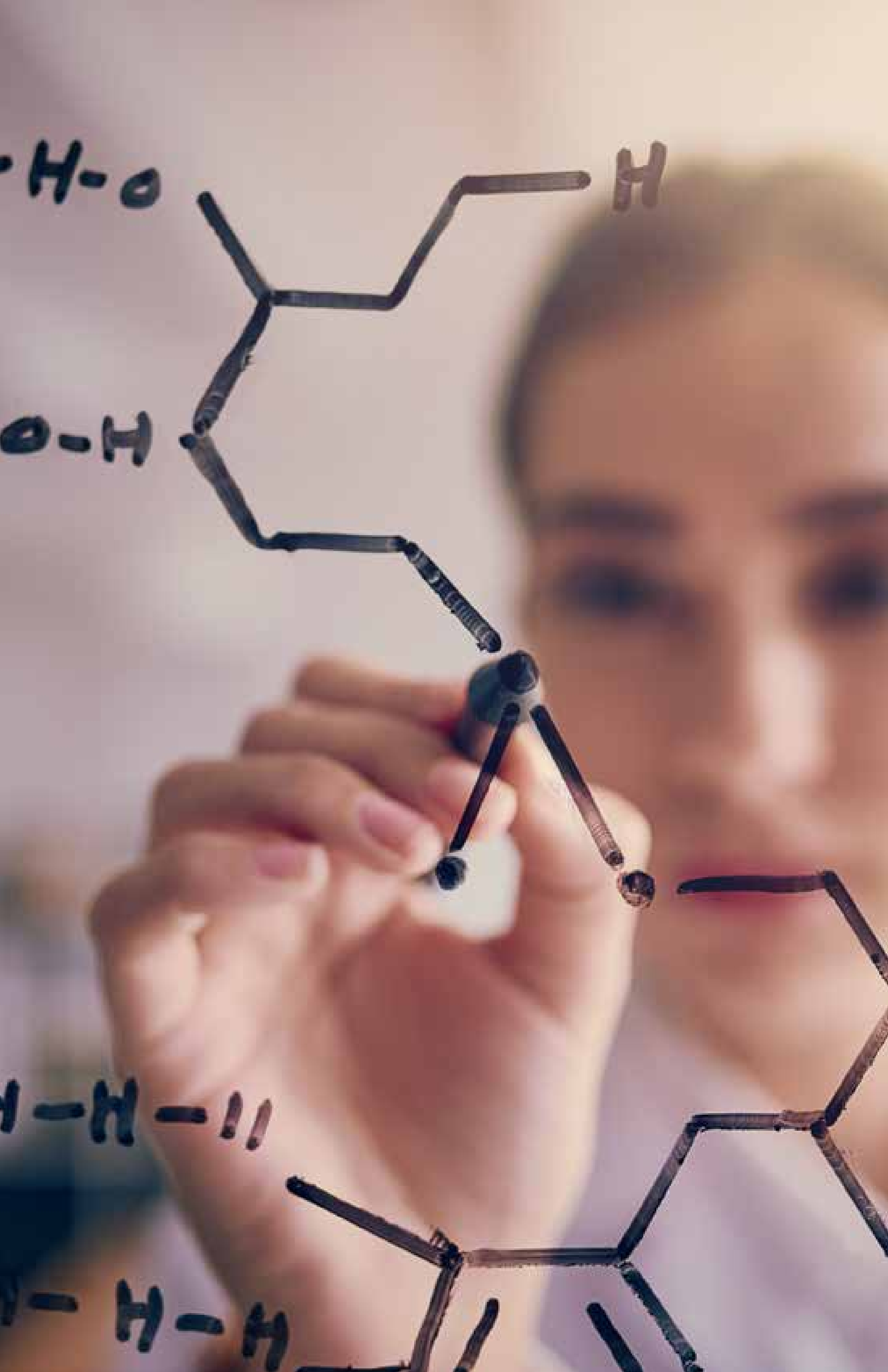
In 2017, the World Health Assembly approved a road map to enhance health sector engagement in SAICM. This identifies concrete actions for the health sector in the sound management of chemicals and was developed to assist Member States and other health sector stakeholders in identifying areas of primary focus for engagement and additional actions relevant for chemicals management at the national, regional and international levels. Among the actions identified, gender is mentioned as an area where there are knowledge gaps to be filled and as a consideration in the development of globally harmonized methods, new tools and approaches

for risk assessment. The road map also includes an activity to include gender and equity as a component in all policies, strategies and plans for the sound management of chemicals and waste.[41]

In addition to the ILO policies mentioned in the previous sections, ILO has policies that are directly connected to women and chemicals. The Maternity Protection Convention (No. 183) was adopted to protect pregnant or breastfeeding women from work that would entail significant risk to her health and safety or that of her child.[*] The accompanying Recommendation (No.191) includes the need for measures to ensure assessment of any workplace risks related to the safety and health of the pregnant or nursing woman and her child, such as work involving exposure to biological, chemical or physical agents which represent a reproductive health hazard. It is specifically stated that the results of the assessment should be made available to the woman concerned.[**]

* https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C183

** https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO:12100:P12100_INSTRUMENT_ID:312529:NO



3. GENDER ANALYSIS ACROSS THE CURRENT EMERGING POLICY ISSUES

OVERVIEW OF THE EMERGING POLICY ISSUES AND ISSUES OF CONCERN

The SAICM Emerging Policy Issues and Other Issues of Concern (from now on referred to as the SAICM EPIs) were established as a way to address issues related to the whole life cycle of chemicals and waste that were not covered by any other body. It is defined as "*an issue involving any phase in the life cycle of chemicals and which has not yet been generally recognized, is insufficiently addressed or arises from the current level of scientific information and which may have significant adverse effects on human health and/or the environment.*"[42]

The identification of a new such issue follows a four-step procedure: a call for nomination of new EPIs; submission of initial information by proponents; review and screening of nominations by the secretariat; and prioritization through consultation and advice from stakeholders and experts.[43] The information required for the process is:

- Magnitude of the problem and its impact on human health or the environment, taking into account vulnerable subpopulations and any toxicological and exposure data gaps;
- Extent to which the issue is being addressed by other bodies, particularly at the international level, and how it is related to, complements, or does not duplicate such work;

- Existing knowledge and perceived gaps in understanding about the issue;
- Extent to which the issue is of a cross-cutting nature;
- Information on the anticipated deliverables from action on the issue.

The decision whether to adopt nominated EPIs is taken by the International Conference on Chemicals Management (ICCM) established under SAICM to undertake periodic reviews of SAICM. Sessions of the ICCM were held in 2009, 2012, and 2015, with more than 120 governments represented at each meeting, ensuring broad buy-in for the adopted issues. All eight EPIs adopted today were identified to have an impact on human health, specifically noting impacts on vulnerable subpopulations such as women and children.

The EPIs are:

- Lead in paint
- Chemicals in products
- Hazardous substances within the life cycle of electrical and electronic products
- Nanotechnology and manufactured nanomaterials
- Endocrine-disrupting chemicals
- Environmentally persistent pharmaceutical pollutants
- Perfluorinated chemicals and the transition to safer alternatives
- Highly hazardous pesticides

It should be noted that there is a certain degree of overlap between these EPIs. For example, while there is an EPI focused on perfluorinated chemicals, these chemicals also have endocrine-disrupting properties and are used in products. That means that different properties and uses of the same chemical may be relevant under different EPIs and may also have different gender- and sex-specific considerations under the different EPIs.

The criteria for identifying EPIs also mention taking any toxicological and exposure data gaps into account. It should be noted that exposure data from most developing countries and countries in transition is scarce and that sex- and gender-disaggregated data is largely missing for most of the EPIs.

LEAD IN PAINT

Lead in Paint was adopted as an Emerging Policy Issue in 2009 in response to studies showing that it was still widely available on the market in developing countries and countries in transition. The same decision also endorsed the establishment of a global, multi-stakeholder partnership to promote phasing out the use of lead in paints, leading to the establishment of the Global Alliance to Eliminate Lead Paint. Resolutions at ICCM3 in 2012 and ICCM4 in 2015 reaffirmed the need and government commitment for national and global elimination of lead paint.

Exposure and health effects

Lead paint is one of the most widespread sources of lead exposure. Lead exposure can irreversibly harm brain development in children at very low levels of exposure and have a lifelong impact. It is generally agreed that one key element in lead toxicity is its capacity to replace calcium in neurotransmitter systems, proteins, and bone structure, altering both function and structure, and thereby leading to severe health impacts. Lead is also known to affect and damage cell structure. Once lead enters a child's body through ingestion, inhalation, or across the placenta, it has the potential to damage a number of biological systems and pathways. The primary target is the central nervous system and the brain, but lead can also affect the blood system, the kidneys, and the skeleton. Lead is also categorized as an endocrine-disrupting chemical (EDC).

Effects on cognitive functions have been confirmed at lower and lower levels of exposure and the WHO have concluded that there is no level of childhood exposure to lead that is known to be without harmful effects.[*] The Institute for Health Metrics and Evaluation (IHME) estimated that in 2016, lead exposure accounted for 63.2% of the global burden of idiopathic developmental intellectual disability.[**]

When a young child is exposed to lead, the harm to her or his nervous system makes it more likely that the child will have difficulties in school and engage in impulsive and violent behavior.[44] Lead exposure in young children is also linked to increased rates of hyperactivity, inattentiveness, failure to graduate from high school, conduct disorder, juvenile delinquency, drug use, and incarceration.[45] Lead exposure impacts on children continue throughout life and have a long-term impact on a child's work performance, and—on average—are related to decreased economic success.

Lead exposure is also harmful for adults. IHME also estimated that in 2016, lead exposure accounted for 10.3% of the global burden of hypertensive heart disease, 5.6% of the global burden of the ischemic heart disease, and 6.2% of the global burden of stroke. A recent study concluded that low-level environmental lead exposure (blood lead concentrations lower than 5 µg/dL) in adults is an important risk factor for cardiovascular disease mortality in the USA.[46]

Based on data from 2017, IHME estimated that lead exposure accounted for more than one million deaths and 24 million years of healthy life lost worldwide due to long-term effects on health.[***] The highest burden was in low- and middle-income countries.

Because of the widespread harm of lead, WHO has identified it as one of ten chemicals of major public health concern.[****]

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* https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

** https://vizhub.healthdata.org/gbd-compare/

*** Ibid.

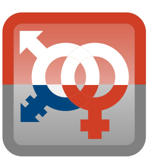
**** https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

Sex-differentiated effects of exposure

Some effects and aspects of exposure to lead are specific for women, especially in relation to pregnancy outcomes. Lead accumulates in the bones and is released into the blood stream during pregnancy, which can both affect the mother and the developing fetus. Lead is also transferred to the infant in a nursing mother through the breast milk. Women aware that they have been exposed to lead previously in life may therefore have to consider abstaining from getting pregnant or risk potential adverse health effects on the fetus. Also, exposure of pregnant women to high levels of lead can cause miscarriage, stillbirth, premature birth and low birth weight.*

While most focus is on neurological effects in children, lead is also a known endocrine-disrupting chemical. It is a known reproductive toxicant and can act on endocrine systems. Lead has the ability to activate the estrogen receptor and initiate transcription of estrogen-activated genes, and estrogenic changes have been observed in experimental animal models. Adverse effects on female reproductive function caused by lead exposure have been supported by animal models, in vitro studies, and human epidemiological studies. In humans, lead alters reproductive hormones in peripubertal girls and healthy premenopausal women.[47]

There are some indications that the neurological effects caused by low-level exposure in children may have sex-dependent elements. For example, one study reported a higher impact of lead exposure on the rate of school suspensions for boys than girls[48], another study a lower Mental Development Index for boys than girls with the same cord blood lead levels at birth.[49]



Gender-differentiated exposure

It is also likely that gender-related social norms can impact how children suffering from cognitive disabilities caused by low level lead poisoning is viewed depending on how boys and girls are expected to behave. It is also likely to magnify underlying challenges such as socio-economic status. However, more studies need to be undertaken in developing countries and countries in transition on this topic.

Lead exposure from paint in adults is likely to have a gender component. Potential occupational exposure includes any type of work that includes lead paint, e.g. paint factories, construction and demolition, painters and in automotive repair shops. These are all generally male-dominated oc-

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* Ibid.

Women are more likely to be exposed to lead from paint in homes, pre- and primary schools, and other indoor environments.

cupations and are likely even more so in traditional societies.[50] Women are therefore more likely to be exposed to lead from paint through lead-contaminated dust generated by deteriorating decorative lead paint. This is typically found in homes, pre- and primary schools, and other indoor environments common for typically female-dominated occupations.

Monitoring data of blood lead levels is scarce except where lead paint has been regulated for decades, such as in the US or the EU. There are some studies published that focus on specific local areas such as lead exposure from lead acid battery recycling facilities but very few include any gender- or sex-segregated data or focus on women.[51] One recent review looked at available studies on blood lead levels in Sub-Saharan African women of childbearing age and found 15 relevant studies. While some identify hot spots such as lead mines, the remaining show a prevalence of elevated lead levels in these women. The weighted mean of blood lead levels was 32.3 µg/dl for women with no known sources of lead exposure, a category that in this study includes lead paint.[52] A review of existing studies was conducted in order to develop a regression model to predict mean blood lead levels in children in those countries for which data is not available. This excludes all studies on specific hot spots, making it more probable to capture lead levels caused by exposure from lead paint, but does not provide any sex-disaggregated data.[51]

Challenges and recommendations

Since nation-wide monitoring data for blood lead levels is virtually non-existent in developing countries and countries in transition, it is somewhat challenging to quantify the extent of the problem. In addition, sex-disaggregated data is even more scarce. Therefore, to develop effective measures to prevent lead exposure in women studies on blood lead levels in women that identify sources of exposure need to be conducted. The results of such studies could be used to develop the most effective measures to prevent lead exposure in women.

Still, the link between lead paint and elevated blood lead levels is very well established from decades of scientific research in the US and the EU.[53] Studies on the availability of lead in paint in countries where no enforced regulations are in place make it clear that without legally binding controls, lead paint will be widely available on the market.[54] A recent study also showed that industrial paint with high levels of lead is in some places also used on playground equipment, constituting a clear health hazard for children.[*] These paints constitute a likely source of lead exposure to women and children and should therefore be considered as such. Preventative efforts that have been implemented in some countries include awareness campaigns directed at women about the hazard of lead paint, especially for pregnant women. An important opportunity for raising awareness is the International Lead Poisoning Prevention Week of Action, which takes place in October every year, organized by WHO in collaboration with other partners of the Global Alliance to Eliminate Lead Paint. As a contribution, WHO and others have developed information materials in all UN languages that can be freely utilized to raise awareness.[**] Other awareness-raising efforts include training on individual practices to prevent exposure from lead[***] and mandatory warning labels on new paint cans to warn about lead dust when sanding and scraping old paint.[****]

However, the only sure way of preventing lead exposure in women from paint is to adopt legally binding controls to limit the production, import and sale of lead paints and to safely remove already existing lead paint from the walls. As of 30 September 2019, only 73 countries (38% of all

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* https://ipen.org/sites/default/files/documents/summary_results_lead_in_playground_equipment_oct24_with_links.pdf

** https://www.who.int/ipcs/lead_campaign/en/

*** http://ecowastecoalition.blogspot.com/2015/07/ecowaste-coalition-launches-first-ever.html

**** https://chemical.emb.gov.ph/wp-content/uploads/2017/03/DAO-2013-24-CCO-Lead.pdf

countries) have adopted such measures, although some of these have outdated and non-protective regulations such as too high limits of lead concentrations in paint and regulations with a wide range of exempted types of paint. To support countries in developing effective regulatory controls on lead paint, UNEP, in cooperation with the World Health Organization, the United States Environmental Protection Agency, and other partners, has developed a Model Law and Guidance for Regulating Lead Paint.[55]

CHEMICALS IN PRODUCTS

Chemicals in Products was adopted as an Emerging Policy Issue in 2009, where government delegates agreed to "*... consider further the need to improve the availability of and access to information on chemicals in products in the supply chain and throughout their life cycle ....*"[56] In order to facilitate this, a Chemicals in Products project was established, with the overall objective of promoting the implementation of paragraph 15 (b) of the Overarching Policy Strategy of SAICM:

> *"To ensure, for all stakeholders:*
>
> - *That information on chemicals throughout their life cycle, including, where appropriate, chemicals in products, is avail-*

able, accessible, user friendly, adequate and appropriate to the needs of all stakeholders. Appropriate types of information include their effects on human health and the environment, their intrinsic properties, their potential uses, their protective measures and regulation;

- *That such information is disseminated in appropriate languages by making full use of, among other things, the media, hazard communication mechanisms such as the Globally Harmonized System of Classification and Labelling of Chemicals and relevant provisions of international agreements;"*[40]

The project was further developed into a Chemicals in Products Programme that was formally welcomed at ICCM4 in 2015 as a voluntary framework for all SAICM stakeholders. Its goal is "*that stakeholders have greater access to the information on chemicals in products that they need to enable them to make decisions and take appropriate action on chemical hazards, exposure, risks and management.*"

The objectives of the CiP Programme are:

- To know and exchange information on chemicals in products, associated hazards and sound management practices within supply chains;
- To disclose relevant information to stakeholders outside the supply chain to enable informed decision-making and actions about chemicals in products;
- To ensure that, through due diligence, information is accurate, current and accessible.

This EPI and associated Programme sprung out of the awareness that lack of transparency in value chains and lack of information about chemicals in consumer products is a significant obstacle to achieving a reduction in risks from hazardous chemicals. Access to information about chemicals in consumer products is therefore fundamental to enable sound management of chemicals throughout the product life cycle.[57]

The Programme focuses on manufactured products and defines products as "*an object that during production is given a special shape, surface or design which determines its function to a greater degree than its chemical composition.*"[58] Since consumer products are rarely produced locally today but rather part of a global production and trade chain, it was agreed that this issue requires global collaboration. The Programme is structured to be applicable to many product sectors and include chemicals in products information broadly throughout product life cycles. However, work is focused on the textiles, toys, electronics and building materials sectors.* For this report, hazardous substances in electronics will mainly be covered under the EPI on hazardous substances within the life cycle of electrical and electronic products.

Exposure and health effects

The life cycle of these product categories includes a wide range of hazardous chemicals that are in many cases similar for all the focus product categories. These include for example toxic metals such as lead, chromium and cadmium; industrial chemicals such as chlorinated paraffins and benzenes; and phthalates such as DBP and BBP.[59, 60] These hazardous substances are carcinogenic, mutagenic, environmentally hazardous, skin and respiratory sensitizing, toxic to reproduction and endocrine-disrupting. Exposure to these chemicals can occur at any stage of the life cycle. Recycling of plastic products constitutes a special case of exposure since hazardous chemicals used in plastics, such as plasticizers, heavy metals, and flame retardants, will remain in the material and end up in the new products.[61,62]

Many hazardous chemicals are used in the production of textiles. They frequently remain in the final product and are unknown both to the retailer and the end user. A report from the Swedish market showed that many of the substances found in textiles are likely to fulfil the criteria of “particularly hazardous substances” to be phased out. These include allergens, toxic metals and biocides. Not only can these cause dermal and oral exposure to the user, they can also contribute to environmental contamination during washing and disposal.[63,64] Toys have been shown to contain brominated flame retardants, endocrine-disrupting chemicals and toxic metals such as lead, cadmium and arsenic.[65] Plastic toys can in addition contain hazardous additives such as endocrine-disrupting bisphenols and phthalates. Electronics are in many countries mandated to contain flame retardants in addition to e.g. various toxic metals and phthalates.** This leads to exposure through contamination of household dust.

Building products contain many hazardous chemicals. A recent report showed that 46 chemicals that meet the criteria of “particularly hazardous substances” in Sweden are used in the construction sector in the EU. These include phthalates, chlorinated paraffins, toluene and styrene.[66] Asbestos is also a well-known hazard still used in building materials in some countries and is present as a legacy in many more.

* http://www.saicm.org/EmergingPolicyIssues/Chemicalsnbsp;innbsp;Products/tabid/5473/language/en-US/Default.aspx

** https://chemicalsinourlife.echa.europa.eu/know-your-electronics

Sex-differentiated effects of exposure

Many of the chemicals used have hazardous properties especially relevant to women, for example Persistent Organic Pollutants (POPs), chemicals that impact reproduction and pregnancy success, and endocrine-disrupting chemicals.

It is difficult to quantify the correlation between chemicals in specific products and the resulting blood levels due to use, since we are exposed to a wide range of chemicals from a variety of products in our everyday life. Therefore, data on type and concentration of chemicals in the products have to be used. Sex- and gender-disaggregated data for chemicals in products is hard to interpret for most products unless there are clear use patterns that result in different potential chemical exposures. For example, personal care products are typically targeted towards men or women, and women generally use more personal care products than men. There is a wide variety of chemicals found in these products that raise health concerns. The California Safe Cosmetics Program[*] requires that any cosmetic product sold in California that contains an ingredient known for or suspected of causing cancer or reproductive harm to humans must be reported. Today, 95 unique ingredients and 107,842 ingredients in total have been reported. These include carcinogens such as formaldehyde, asbestos and per- and polyfluoroalkyl substances (PFAS); neurotoxicants such as lead and toluene; and endocrine-disrupting chemicals such as triclosan and parabens. Studies in Asia[**] and Africa[67] have shown that mercury is still being used in skin whitening creams, mostly used by women. Also, a range of hazardous chemicals have been detected in menstrual products, such as pesticides, phthalates, and solvents.[***]

Biomonitoring studies targeting specific chemicals can provide clues as to what type of product they come from. While not all studies report the biological sex of the participants, reports on concentrations in e.g. human milk and umbilical cord blood can be utilized in addition to blood level studies. Data from developing countries and countries in transition is scarce, but there is data from national monitoring programs conducted by the The Centers for Disease Control and Prevention in the US[****] and by Health Canada.[*****]

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* https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CSCP/Pages/SummaryData.aspx
** https://www.bloomberg.com/news/features/2019-08-28/mercury-taints-unknown-number-of-skin-lightening-beauty-creams
*** https://www.womensvoices.org/whats-in-period-products-timeline-of-chemical-testing/
**** https://www.cdc.gov/exposurereport/index.html
***** https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/human-biomonitoring-environmental-chemicals.html

A recent project in the EU, HBM4EU, has started collecting Union-wide biomonitoring data.* These programs together with many scientific papers show that a range of chemicals are typically detected in women. For example, one study showed that pesticides, PFCs, phenols, PBDEs, phthalates, polycyclic aromatic hydrocarbons (PAHs) and perchlorate were detected in 99% - 100% of pregnant women.[68] Another study showed that 88% of 2,000 pregnant women monitored in Canada had detectable urinary concentrations of the endocrine-disrupting chemical bisphenol A (BPA).[69]

Gender-differentiated exposure

It is also important to assess sex and gender differences in exposure to different chemicals at different stages of the life cycle to identify the impact on human health.[57]

Women constitute an especially high proportion of the workforce in the textile and electronics production sectors. It was estimated in 2014 that women represent, on average, 45 percent of the workforce in the textile industry and 68 percent of the workforce in the clothing industry. However, there is high variance, and in some countries, women can constitute

* https://www.hbm4eu.eu/

Women constitute an especially high proportion of the workforce in the textile and electronics production sectors. These are very chemical-intensive occupations and include thousands of chemicals, many of them hazardous.

as much as 90 percent of the employees in these industries.[70] Women also constitute a majority of the workforce in the production of electronics.

Production of both textiles and electronics are very chemical-intensive and include thousands of chemicals, many of them hazardous. For example, women in textile production are exposed to chemicals causing cancer, endocrine-disrupting chemicals and allergens.[71] The American Public Health Association concluded in a policy statement from 2012 that chemicals used in the electronics sector is associated with a variety of adverse health outcomes in women, including cancer, reproductive disorders and congenital anomalies in offspring. All of these have been identified in manufacturing facilities located in China, Korea, Malaysia, and elsewhere. They also highlight that female workers in the semiconductor and electronics industry may also be at increased risk for spontaneous abortion and subfertility, as well.[72]

There is a gender division in exposure to hazardous chemicals in building products, where workers in this field are predominately male. However, both women and men can be exposed to these chemicals in homes, schools and other buildings when e.g. solvents evaporate from the materials, and paint containing lead and other hazardous substances deteriorates and releases chemicals to the indoor dust. High temperatures, high humidity and low air circulation increase rate of release. One study estimated that a typical indoor environment can contain more than 6,000 organic substances, of which around 500 can be attributed to construction products.[*] For example, PVC flooring contain several chemical additives, such as stabilizers and plasticizers, that can leach out during cleaning. Since women still do the majority of the household cleaning in most countries, they are therefore more likely to be exposed through this route.[73]

There may be gender differences in the use of textiles, toys and electronics, but any resulting patterns of chemical exposure is unknown. Still, while gender differences may be hard to discern, these products have all been shown to contain a wide variety of hazardous chemicals added during production or introduced during recycling. For example, the European Union Rapid Alert System for Non-Food Products (RAPEX) registered 559 alerts in 2019 for chemicals in consumer products.[**]

* Wargocki P., 2004. Sensory pollution sources in buildings. Indoor Air 14, 82-91

** https://ec.europa.eu/consumers/consumers_safety/safety_products/rapex/alerts/?event=main.listNotifications&lng=en

Challenges and recommendations

The large number of hazardous chemicals used in products such as electronics, toys, building products and textiles constitutes a massive challenge at all stages of their life cycle. In order to implement gender-sensitive efforts and to protect women, it is key that the chemical content is known and communicated throughout the life cycle of the products. Also, additional studies of the impact of hazardous chemicals in the life cycle of these products are needed. Based on existing and new knowledge developed, measures to identify, address and substitute chemicals that are especially harmful to women with safer alternatives can be undertaken. Meanwhile, women working in production and disposal should receive training and personal protective equipment to handle hazardous chemicals safely.

It is especially challenging to monitor chemical content of products in countries with low capacity such as many developing countries and countries in transition. Product labeling to inform about chemical content that is hazardous for women has been implemented for some product groups in certain countries that could be built upon before these chemicals have been phased out. These could be complemented with other consumer tools to identify chemical content and special hazards for women to empower them to choose safe products.

Chemicals in products and their disposal are regulated to a varying degree under international treaties, regional and national regulations. However, noting the number of hazardous substances still detected in consumer products around the world with evidence of health impacts on women, it is clear that more ambitious controls that are easy and effective to enforce are needed. This could include restricting the use of groups of chemicals instead of the chemical-by-chemical approach mainly utilized today. For example, there is a new proposal in the EU to regulate more than a thousand skin-sensitizing substances that can currently be present in commercially available textile and leather goods.[*] The supporting documentation references several studies on this group of substances where it has been shown that women are often more affected by them than men.[74]

In order to implement these protective measures, one other important aspect is to make sure regulatory controls mandate straightforward detection methods, such as using screening tools like x-ray fluorescence instead of other more complicated lab approaches such as migratory limits. Also, regulations on hazardous chemicals restricted for use in consumer products in certain countries and regions should include prohibitions on export of these products containing these chemicals.

* https://echa.europa.eu/restrictions-under-consideration/-/substance-rev/23405/term

Other soft regulatory approaches that have been utilized include incentivizing producers to replace hazardous substances in consumer products trhough procurement criteria and taxes on hazardous chemicals in electronics and textiles. These approaches could include measures that specifically target the chemicals that are most hazardous to women.

There are many voluntary tools in place already today that can be used by consumers to find hazardous chemicals in products. These include voluntary, third-party ecolabeling schemes such as the EU Ecolabel*, the GreenScreen Certified label**, the Lead Safe Paint certification***, and the OEKOTEX label for textiles.**** There are also a range of tools for producers to identify hazardous chemicals in their products and replace them with safer alternatives. These include for example the ChemSec Marketplace***** and the Healthy Building Network.****** While the ecolabeling schemes do not include any gender aspects, both the tools from ChemSec and from the Healthy Building Network help identify endocrine-disrupting chemicals.

* https://ec.europa.eu/environment/ecolabel/eu-ecolabel-for-consumers.html
** https://www.greenscreenchemicals.org/
*** www.leadsafepaint.org/
**** https://www.oeko-tex.com/en/
***** https://marketplace.chemsec.org/
****** https://healthybuilding.net/work

HAZARDOUS SUBSTANCES WITHIN THE LIFE CYCLE OF ELECTRICAL AND ELECTRONIC PRODUCTS

This issue was brought to the attention of the ICCM2 in 2009, where the dumping of near-end-of-life and end-of-life electrical and electronic products in developing countries was recognized as a global concern. While electronic waste is covered by the Basel Convention, it was also recognized that upstream actions are needed and that dumping leads to illegal transboundary movement of hazardous constituents of these products and that a broader, life cycle approach was needed.[42] The actions on hazardous substances within the life cycle of electrical and electronic products (HSLEEP) were further widened at ICCM3, where it was decided to continue to work to identify, compile and create an international set of best practice resources on topics in this area.[75]

This SAICM emerging policy issue covers design, production and use, and end-of-life aspects of hazardous chemicals in electrical and electronic products. One aspect of end-of-life is the handling of electronic waste. Waste Electric and Electronic Equipment (WEEE) are electrical and electronic equipment products, which rely on either electric current or electromagnetic fields to work (i.e. which have a power supply or a battery), that are discarded with no intention of further use by owners.

As noted in the ICCM resolution, the electronic waste sector is also of major concern. E-waste is now the fastest-growing waste stream in the world, estimated to have reached 48.5 million metric tons in 2018. Personal devices, such as computers, screens, smartphones, tablets and TVs constitute half of all e-waste and the rest is larger household appliances and heating and cooling equipment.

Transboundary movement of hazardous and other waste, including e-waste, is regulated internationally under the Basel Convention. There are also regional Conventions and agreements that provide further controls, such as the Waigaini Convention that prohibits Parties from developing Pacific Islands from importing any hazardous or radioactive wastes from outside of the Convention area, and the Bamako Convention that prohibits the import of any hazardous waste into Africa.[76] In addition, the Basel Convention BAN amendment came into force in December 2019, prohibiting the export of hazardous wastes (including most e-wastes) from countries in Annex VII of the Convention (OECD, EU, Liechtenstein) to countries not in Annex VII, if either of the exporting or importing countries have ratified the amendment.[77] Some countries and regions adopted controls on the export of waste, including e-waste, to developing countries before that. The Waigaini Convention prohibits Australia and New Zealand from exporting hazardous or radioactive wastes to the South Pacific Forum Islands*, and the EU has banned the export of e-waste to developing countries.

However, large amounts of e-waste are still shipped illegally. 80% of all e-waste globally is estimated to end up in landfills or be disposed of by informal workers in poor conditions.[78] Only 20% of e-waste is documented to be collected and disposed of/recycled under safe conditions. The rest is subject to illegal trade and dumping.[79] For example, a 2019 report estimated that 1.3 million metric tons of discarded electronic products are exported from the EU in an undocumented way every year.[80]

Exposure and health effects

A range of hazardous chemicals are used in the production of electronics. This includes the hazardous substances in the electronics themselves such as flame retardants, the toxic metals mercury, cadmium, and lead, and various hazardous chemicals in the plastics, as well as the organic solvents and other hazardous chemicals used to produce and prepare the components for the electronics. These hazardous substances are carcinogenic, muta-

* https://www.forumsec.org/

genic, environmentally hazardous, skin and respiratory sensitizing, toxic to reproduction, and endocrine-disrupting.

Sex-differentiated effects of exposure

A range of studies of workers in different electronics manufacturing facilities have shown sex-differentiated effects in the United States. An investigation of 32,000 worker deaths in IBM between 1969 and 2001 identified several specific cancers and other causes of death that were significantly elevated. Results showed excesses of brain, kidney, and pancreatic cancer, along with melanoma, in male manufacturing workers and that female workers had higher-than-expected numbers of deaths from kidney cancer, lymphoma, and leukemia.[81] Another study on mortality among autoworkers manufacturing electronics showed an excess of mortality among female workers, and that this may indicate that women were more likely than men to hold non-skilled or non-salaried jobs with greater potential exposure to production processes.[82] A third example from the United States is a study that found that solvent exposure in women working in the electronics industry during the first trimester of pregnancy was significantly associated with spontaneous abortion.[83]

In the Republic of Korea, an analysis of epidemiological data found evidence suggesting reproductive risks to women from semiconductor fabrication jobs including spontaneous abortion, congenital malformation, and reduced fertility.[84] A subsequent examination of reproductive risks among female microelectronics workers aged 20 – 39 years old found a significantly higher risk for spontaneous abortion and menstrual aberration.[85] A study of leukemia and non-Hodgkin lymphoma (NHL) cases from the Giheung Samsung plant reported to the Supporters for the Health and Rights of People in the Semiconductor Industry (SHARPs), found 17 sick workers, with 11 of them women – all 30 years old or younger.[86] A study to analyze the risk for workers in the Korean chip industry was finalized by the Government Agency Korea Workers Compensation & Welfare Service (KCOMWEL) in 2019. They looked at data from around 200,000 people who worked at chip labs at four corporations including Samsung Electronics Co., Ltd. and SK Hynix between 2007-2017. The study concluded that blood disorders were linked to work exposure and that female workers were more likely to develop leukemia than the average population. In addition, more female than male workers aged 20-24 developed a blood disorder and were more likely to fall victim to non-Hodgkin lymphoma.[*]

* The Agency report is not available online but information in English is posted here https://stopsamsung.wordpress.com/2019/05/23/s-korean-govt-admits-relatedness-of-fatalities-and-illnesses-in-semiconductor-industry/

There are a multitude of studies verifying the close association between e-waste handling and adverse health impacts. Many of these studies show sex-differentiated impacts and many of the types of hazardous chemicals commonly found in e-waste, affect women's general reproductive and endocrine functions. For example, one review showed that there are consistently reported effects such as increases in spontaneous abortions, stillbirths, premature births, and reduced birth weights and birth lengths. Chemicals identified in these studies included polycyclic aromatic hydrocarbons, polybrominated diphenyl ethers, polychlorinated biphenyls, and perfluroalkyls.[87] In addition, women exposed to chemicals in e-waste such as heavy metals, flame retardants, PCBs, and phthalates may suffer from anemia, fetal toxicity, hormonal effects, menstrual cycle irregularities, endometriosis, autoimmune disorders, and cancers of the reproductive system.[88]

E-waste work may also be tied to fertility problems. Lead and mercury exposure within the first trimester of pregnancy may affect fetal development, resulting in potential neurobehavioral development problems, low birth weight, or spontaneous abortion and birth defects.[89] Ambient air pollution, a consequence of burning e-waste in open-air pits, is also linked to reduced fertility. The damage to reproductive function after several years of exposure to this pollution is irreversible. For many women, this damage has occurred before they even reach reproductive age.[90]

Gender-differentiated exposure

Women have played a prominent role in electronics manufacturing from the early 20th century when mass production industries started to grow. At the beginning of the century, the working force was generally made up of men. However, when these factory workers left to serve in the armed forces during the first World War, women were increasingly employed. In the 1960s, the electronics industry was the largest employer of women in the United States. Global growth in electrical and electronic equipment production and consumption has increased exponentially over recent decades.[91] Chemicals are used for many purposes in the production, e.g. as flame retardants in electronic casings and organic solvents for cleaning components, which means that increased production inevitably leads to an increase in the use of chemicals.

In subsequent decades, the electronics industry moved to Latin America and Asia, where it rapidly expanded into using complicated supply chains with numerous small sub-contractors – many of which have even less capacity for chemicals management than large companies. In Asia, young

Young women are the primary labor force in the electronics industry in Asia. Studies have shown that they have a higher risks of health impacts, such as spontaneous abortions and leukemia than the general population.

women became the primary labor force as a result of a targeted effort by companies based on physical stereotypes, social stereotypes, and economic positions.[92] The industry has substantially grown in Asian countries such as Malaysia, Taiwan, Korea, Vietnam, and many others.[92]

In the 1970s, many international companies began electronics manufacturing in Taiwan. Young women joined the industry and subsequently suffered from occupational diseases. In the 1990s, regulators found that RCA had polluted groundwater with trichloroethylene, perchloroethylene, and other toxic chemicals. Studies of former workers and community residents found an increased risk of liver cancer and an increase in breast cancer.[93]

The issue of women in electronics is an ongoing matter of concern due to the large use of chemicals and the high proportion of women workers. In Vietnam, the electronics industry amounted to almost 13 billion USD and had a growth rate of 41% between 2006 and 2016. The industry employed 634,440 people in 2016, where around 70% of the workforce was female. Over 85% of those workers were under the age of 35.[94]

E-waste often contains hazardous chemicals, can have an adverse impact on health, and accumulates in the environment. In many countries, women and children play dominant roles with potential exposures from chemicals in products and those released from the burning and disassembling e-waste. In some countries, the work tasks included are segregated by gender where the men collect the waste and women and children conduct the manual processing and therefore are more exposed to the hazardous chemicals in the waste. The work includes burning cables, acid baths, breaking equipment open, and breaking apart soldered components. This type of work tends to be performed by workers at temporary sites, residences, crude workshops, and in open public spaces and results in a variety of toxic chemical exposures. These include polychlorinated biphenyls (PCBs) and other persistent organic pollutants present in fluids, lubricants, and coolants, and polyvinyl chloride, dioxins, furans, brominated flame retardants, and polycyclic aromatic hydrocarbons (PAHs) from the burning of cables.[95]

Challenges and recommendations

As noted in the decision to adopt HSLEEP as an emerging policy issue, both upstream and downstream action is needed. An overall action increasingly called for is to reduce the amount of new electronics produced by increasing the lifespan of electronics, e.g. through increased ability to repair and replace parts of the equipment. Reducing the volume of electronics produced would also lower the amounts of chemicals handled and added to electronics. This would benefit women especially engaged in producing electronics and handling e-waste.

Despite the large female work force this large industry employs, current information about its occupational exposure and/or its environmental impact is mostly lacking. To address this issue several actions need to be taken in conjunction. The first step is to identify occupational hazards such as exposure to hazardous chemicals and assess both sex- and gender-specific risks. Any risks not mitigated need to be addressed and managed through suitable personal protective equipment for workers, including training to ensure correct use. In addition, it is important that workers are informed about the chemicals they handle and their hazards, and also trained on how to handle chemicals safely.

Where not already in place, regulations need to be adopted that protect workers from occupational exposure to hazardous chemicals, with a priority on chemicals especially hazardous for women. New regulations could utilize already existing lists identifying chemicals that are prohibited for use in electronics, such as the chemicals listed in the EU Restriction of Hazardous Substances (RoHS) Directive. Product development could be improved by including analysis of potential gender-differentiated concerns such as impact of chemicals especially harmful to women, including precaution when considering chemicals where there are early warnings about hazard. Innovation and implementation of new, safer technologies should be encouraged. By promoting health-protective limits of allowed chemical contamination of e-waste that take the vulnerability of women into account, the women handling such waste would benefit.

One of the challenges related to the sound management of waste electronic products is that their chemical content is unknown. This contributes to the health hazards for women engaged in e-waste handling. Tools to promote transparency and support safe handling of end-of-life electronics include systems to track chemicals added in the production process and appropriate labeling for safe handling, including warnings about chemical content especially hazardous for women. A model to build upon could be the International Material Data System (IMDS) used to record all materials (and their chemical content) present in finished automobile products throughout the manufacturing process.

As described above, a large proportion of all e-waste is shipped illegally and disposed of by informal workers that often are women in poor conditions. Therefore, closer monitoring and enforcement of international, regional and national regulatory controls would serve to protect women by reducing the amount of e-waste entering countries with low capacity for handling them in a safe way. Also, the principle of extended producer responsibility could be implemented and utilized in such a way that it enables both importers and local producers to empower women to handle the waste safely and to play an effective role in e-waste management. This includes providing personal protective equipment, awareness-raising about increased hazards for women from certain chemicals, and training for safe handling. All of these steps would improve working conditions for the many women engaged in the e-waste sector.

NANOTECHNOLOGY AND MANUFACTURED NANOMATERIALS

Nanotechnology and nanomaterials was adopted as an emerging issue at ICCM2 in 2009, where it was noted that it poses both environmental and health risks and therefore justified a precautionary approach.[42] At ICCM3 in 2012, a wide range of activities were added to the Global Plan of Action that included for example technical guidelines and harmonized standards, awareness-raising, and approaches to protecting workers, the public, and the environment from potential harm related to manufactured nanomaterials.[75]

The OECD established its Working Party on Manufactured Nanomaterials[*] in 2006, focused on human health and environmental safety implications of manufactured nanomaterials, primarily in the chemicals sector. The aim is to assist countries in assessing safety aspects of manufactured nanomaterials and promote international cooperation on the human health and environmental safety of manufactured nanomaterials. It has since published a series of reports on areas such as hazards of certain nanoparticles, guidance on testing methods, and expert opinions on a range of aspects related to nanoparticles.[**]

* https://www.safenano.org/knowledgebase/standards/working-party-on-manufactured-nanomaterials/

** http://www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm

No definition of nanomaterials was included in the ICCM decisions, but ISO/TS 80004 defines it as a "*material with any external dimension in the nanoscale or having internal structure or surface structure in the nanoscale*", i.e., a size between 1 nm to 100 nm. In comparison, the approximate diameter of the DNA helix is 2 nm, a small virus 30 nm, and a red blood cell approximately 9,000 nm.

It should be noted that this issue includes both nano-sized objects as well as nanostructured materials, which have internal or surface structures on the nanoscale. Since it is a size definition, nanoparticles do not belong to any specific group of chemicals. However, they can be divided further according to composition, such as solid nanoparticles (i.e. metals), carbon-based nanoparticles, and polymer-based nanoparticles. Some well-known nanomaterials are titanium dioxide nanoparticles, silver nanoparticles, carbon nanotubes and nanoplastics.

Exposure and health effects

Effects of nanomaterials can be seen on different levels of biological organization after exposure. They have been shown to catalyze the formation of reactive oxygen species, some can bind to functional groups on proteins and other macromolecules, they can disrupt cell membrane integrity and cause local inflammations.[96] However, when considering the specific health effects of a certain nanomaterial, it is important to take its specific properties into account since nanomaterials can differ e.g. in size, shape, surface area, chemical composition and solubility.

Nanomaterials typically enter the human body through inhalation, ingestion and absorption through the skin. Small (1-10 nm) nanoparticles can then enter virtually all types of cells. Once in the cell, they have been shown to cause damage to the mitochondria, which are vital for normal function of cells. They may also have the ability to interact with the cell nucleus. Nanomaterials that remain in the blood stream can enter organs like the liver, kidney, heart or spleen where they might cause diseases. Inhaled nanoparticles can cause damage and disease to the lungs and may even be able to migrate from the nose to the brain via the olfactory tract.[97] Health effects linked to exposure to nanoparticles include effects on all major organs, such as lung fibrosis, liver damage and nephrotoxicity.[98]

Because of their ability to enter into cells and organs, an emerging field of use of nanoparticles is in medicine, so-called nanomedicine. Areas under assessment and development is use for diagnosis, monitoring, control, prevention and treatment of diseases. Uses today include treatment of certain types of cancer, anti-fungal treatment and iron deficiency treatment.[99]

Nanomaterials are used in a wide variety of everyday consumer products, including textiles, cosmetics, personal care products, and tattoo inks.

While nano-sized substances are used for medical purposes, the most widespread use and exposure is through production, use and disposal of consumer goods and in food and food packaging. Examples of food additives with registered numbers include silver (E174), titanium dioxide (E 171), and silicon dioxide (E 551). With the rapid expansion of nanotechnology, a large number of everyday products on the market today now contain nanomaterials such as sports equipment, toys, fabrics, textiles and apparel, plastics, electronic products, cosmetics and personal care products, tattoo inks and paint.*

One of the first concerns to be investigated was carbon nanotubes (CNTs), i.e. graphene sheets rolled into cylinders, that are used in a wide variety of applications to reduce their weight and improve water- and wear-resistance such as textiles, plastics and household products. These tubed can be single-, double-, and multiwalled depending on how many layers of graphene make up the nanotube. As evidence has emerged on effects primarily in rodents, the International Agency for Research on Cancer (IARC) has concluded that a certain group of multiwalled carbon nanotubes (type MWCNT-7) are "possibly carcinogenic to humans". While there was not enough evidence available to make a conclusion for other types of carbon nanotubes and their effects, results of rodent studies indi-

* https://euon.echa.europa.eu/what-kind-of-products-contain-nanomaterials

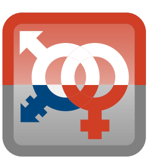
cated genotoxicity, lung inflammation, granuloma formation and fibrosis from exposure to single-, double-, and multiwalled nanotubes.[100] Also titanium dioxide has recently been classified in the EU as a suspected carcinogen (cat 2.) by inhalation. Other, sex-specific effects of nanoparticles is described in the next section.

This SAICM EPI is primarily focused on engineered nanomaterials, i.e. materials that are intentionally manufactured for specific purposes. However, while not specifically addressed under SAICM, nanoparticles are also unintentionally produced in combustion processes leading to air pollution and resulting diseases. These include oxidative stress, inflammation and cancer in the lungs.[101]

Sex-differentiated effects of exposure

Most toxicity studies have been conducted on animals, such as rodents, and indicate sex-specific responses to exposure. Nanocarbon tubes have been shown to harm female reproduction, cross the placenta and cause embryo lethality, early miscarriages and fetal malformations in female mice.[102]

Titanium dioxide nanoparticles can cause ovarian dysfunction, affect genes regulating immune response, disrupt the normal balance of sex hormones and decrease fertility. In addition, many nanoparticles can cross the placenta where they can cause altered development of internal organs and morphology as well as defects in the reproductive and nervous systems of the offspring.[103] It has also been shown that nanoparticles of titanium dioxide exerted higher hepatic toxicity in female rats than male, indicating a sex-differentiated response.[104]



Gender-differentiated exposure

Like many other of the EPIs, gender concerns associated with nanomaterials involve their whole life cycle of manufacturing, product use, and waste. Nanomaterials are used in a wide variety of consumer and industrial applications ranging from cosmetics, sunscreen, sports equipment, polymer and rubber materials, textiles, electronics, and building materials. The number of people working in nanotechnology is uncertain but it was estimated in 2013 that there were 400,000 workers worldwide and that the prediction for 2020 was an increase to 6 million workers.* Workers have the highest exposure to nanomaterials, including through handling, cleanup, maintenance, and dealing with wastes.[105] Because of the wide use of nanoparti-

* https://blogs.cdc.gov/niosh-science-blog/2013/12/09/nano-exp/

cles and nanomaterials, the number of female workers is not known. One case of occupational exposure involving women was reported from China in 2009, where seven female workers working in the same department in a printing plant were diagnosed with severe pulmonary fibrosis. On further investigation, polyacrylate nanoparticles were found in the used paste and dust particles of the non-ventilated workplace. Traces of polyacrylate nanoparticles were also found in the lower respiratory system, chest fluid and lung biopsies of these women. Nanoparticles were also found lodged in the pulmonary epithelial and mesothelial cells of the chest fluid. Two of the women died (aged 19 and 29).[106]

Nanoparticles such as titanium dioxide are widely present in products used by women, including food additives, cosmetics, and many consumer products. There are some labeling requirements for cosmetics and food in relation to nanomaterials, but in most products in most of the world, consumers have no way of knowing if the products they use contain nanoparticles.

Challenges and recommendations

Much is still unknown about the diverse group of nanoparticles and their impact on human health, including impacts on women. However, indications from scientific studies indicate sex-dependent impacts leading to e.g. lower reproductive success. Therefore, it is important to prioritize research into this issue to understand both the hazard for women and identify appropriate measures to prevent exposure. Nanoparticles are used extensively in products designed for women and the field of nanotechnology is growing rapidly. This development is likely to outpace the speed of generating robust health data and adopting regulatory controls in many cases. Therefore, a first precautionary step to protect women's health would be to start requiring labeling of products containing nanoparticles that are used mostly by women. This will empower women consumers to choose products with or without nanomaterials. This type of labeling is currently adopted for cosmetics in the EU, where products containing nanomaterials must be disclose the name of the material followed by "nano" in the list of ingredients.[107]

It is also important to make efforts to investigate the impacts of nanotechnology on women workers and to put appropriate measures in place for protection. These could include assessing high-risk processes and materials, and employing suitable protective equipment designed to capture nanoparticles, coupled with trainings in safe handling.

As a matter of precaution and allowing for consumer choice, products containing nanomaterials should be labelled. This is already in place in the EU for cosmetics.

Waste handling is also a source of exposure to women. While there is a huge gap in information regarding the impact of nanoparticles on women from waste handling, several protective approaches could be put in place based on precaution. A key measure would be to enable easy identification of waste containing nanomaterials through labeling or other information systems to enable women waste workers to use protective equipment and other measures to safeguard their health. There is also an immediate need to investigate the hazard from exposure to nanomaterials for women workers, especially during pregnancy.

Guidance on voluntary labeling of consumer products containing manufactured nanomaterials was developed in 2013. While this is primarily aimed at manufacturers, retailers, the packaging industry and marketing managers, it could be utilized by companies to inform users and waste handlers, as well. This guidance includes adding the word “nano” on the product label to enable consumers to make informed purchasing decisions.*

* https://www.iso.org/standard/54315.html

ENDOCRINE-DISRUPTING CHEMICALS

Endocrine-disrupting chemicals (EDCs) was adopted as an Emerging Policy Issue at ICCM3 in 2012, where governments recognized the potential adverse effects of endocrine disruptors on human health and the environment, and the need to protect humans, and ecosystems and their constituent parts that are especially vulnerable. Several government representatives also concluded that it was necessary to apply the precautionary principle, the-right-to-know principle and the no-harm principle in dealing with endocrine-disrupting chemicals and that global action must have at its core producer responsibility and the principle of substitution to ensure that the chemicals were progressively replaced with safer alternatives.[75]

The ICCM decision does not provide a definition of EDCs. However, the global assessment of the state-of-the-science of endocrine disruptors published in 2002 by WHO under the International Programme on Chemical Safety provides the following definition that has also been adopted by the OECD and the EU:

> *"...an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) populations. A potential endocrine disruptor is an exogenous substance or mixture that possesses properties that might be expected to lead to endocrine disruption in an intact organism, or its progeny, or (sub) populations."*[108]

Endocrine disruption is caused by a wide range of chemicals used in a multitude of applications. This means that most of the other EPIs include hazardous chemicals that are EDCs, as well as chemicals under the Minamata, Stockholm, Basel and Rotterdam Conventions.

Exposure and health effects

Many chemicals can cause effects on the endocrine system. In humans, this includes the hypothalamus, the pituitary gland at the base of the brain, the thyroid gland in the neck, the adrenal glands in the abdomen next to the kidneys, the gonads and certain parts of the pancreas. During pregnancy, the interface between mother and fetus (the so-called feto-placental unit) is a major site of protein and steroid hormone production and secretion. These hormones are crucial to avoid complications and adverse outcomes during pregnancy.[109] Hormones are also secreted by many other organs as a secondary function, such as the heart, body fat, muscles, liver, intestines, and kidneys.[22] Some endocrine glands also have non-endocrine functions, such as the pancreas, that produces both digestive enzymes that are not part of the endocrine system as well as insulin, which is a hormone.

TABLE 1: A FEW EXAMPLES OF ENDOCRINE-DISRUPTING CHEMICALS

Category/Use	Example EDCs
Antibacterials	Triclosan
Biocides	Tributyltin (TBT)
Children's products	Diethyl phthalate (DEP)
Electronics and Building materials	Brominated flame retardants, PCBs, Chlorinated paraffins
Food contact materials	Benzophenones, Bisphenol A
Personal care products	Paraben
Medical tubing	Diethyl phthalate (DEP)
Pesticides	Sulfluramid
Textiles, clothing	Perfluorochemicals, 4-Nonylphenol

Source: Overview Report I: A Compilation of Lists of Chemicals Recognised as Endocrine Disrupting Chemicals (EDCs) or Suggested as Potential EDCs, Prepared by The International Panel on Chemical Pollution (IPCP), 2016.

http://wedocs.unep.org/handle/20.500.11822/12218

Women and men share the same hormones but at different levels and with differences in the ways they affect the body. Sex hormones such as testosterone and estrogen that are fundamental for e.g. sex differences and reproductive functions are present in both males and females, but at different levels. There are also other sex differences related to the endocrine system and its response. For example, thyroid disorders are more frequent in women than in men. Another example is that while type 1 diabetes is equally common in men and women, the disease increases the cardiovascular risks for women more than men.[110]

The regulation of the endocrine system is crucial for biological processes and physiological functions throughout the life span of an individual. Though the endocrine system is highly adaptive, chemicals that perturb endocrine signaling beyond the limits of the adaptive response can have severe consequences. For example, disturbances of the fetal thyroid hormone levels can have critical effects on brain development and function. During critical developmental windows when organisms are highly susceptible, even mild endocrine disruption can lead to infertility, growth disturbances, sleep disorders, and weight gain. It is therefore vital that endocrine hormones are released at the right time in the correct concentrations, and that the endocrine glands can adjust this in response to a changing environment to enable a healthy life.

Endocrine-disrupting chemicals are found in a wide variety of consumer products. For example, measurements of EDCs in 213 consumer products found phthalates in a vinyl pillow protector, diapers, tub and tile cleaner, dish liquid, laundry bleach, stain remover, hand sanitizer, hand soap, bar soap, body lotion, shampoo, conditioner, shaving cream, face lotion, facial tissues, deodorant, foundation, lipstick, lip balm, shower curtain, car interior cleaner, car air freshener, dryer sheets, polish/wax, hair spray, perfume, body wash and nail polish. Alkylphenols were found in a vinyl pillow protector, diapers, surface cleaner, tube and tile cleaner, laundry bleach, body lotion, glass and floor cleaners, laundry detergent, bar soap, shampoo, shaving cream, face lotion, toothpaste, lip balm, foundation, lipstick, and mascara. Parabens were found in hand soap, body lotion, shampoo, conditioner, shaving cream, face lotion, facial cleanser, foundation, lipstick, mascara, hair spray, and sunscreen.[111]

In Denmark, a survey conducted in 2012 reported that pregnant women may be at risk from exposure to endocrine disruptors. Eight consumer product groups were selected through an analysis of the target group's product use, including e.g. skin cream for pregnant women, cell phone covers and sneakers. First, a qualitative assessment of which potential EDCs the products contained was performed based on the material of the product. In a second step, a selection of products from the eight groups

Many consumer products contain phthalates, alkylphenols, parabens, and other EDCs, threatening health, particularly for women during pregnancy, without sufficient labeling about risks.

were analyzed to assess content of certain EDCs from the product, finding e.g. phthalates, bisphenol A and octamethylcyclotetrasiloxane (D4). A hazard assessment was made for the detected EDCs and an assessment of risk based on various exposure scenarios for pregnant women, including risks due to combination effects of the substances. The outcome of the risk assessment was that there may be an increased risk of endocrine-disrupting effects for women due to the presence of EDCs in many types of consumer products used every day by pregnant women.[112]

Similar to other EPIs, data from developing countries and countries in transition is more scarce than for e.g. the EU. However, there is emerging evidence from all regions in the world about the widespread use and detection of endocrine-disrupting chemicals. The urgent need to address EDCs in Africa was emphasized at the First African Conference on Health Effects of Endocrine Disruptors: Challenges and Opportunities for Africa in 2017. The scientific experts participating in the meeting highlighted the challenges in Africa, with its increased urbanization and economic development leading to more chemicals use. They noted that in African countries, like in many other developing countries, most of the human and environmental contamination occurs from the use and disposal of these products and not from manufacturing. For example, agriculture is the largest economic sector in many countries and many pesticides are EDCs. There is also increased use of various personal care products and other consumer products that contain EDCs.[113] A recent report from India reviewing available studies on the country situation highlighted a range of EDCs such as Bisphenol A (BPA), triclosan, phthalates and parabens detected in consumer products and the environment in different parts of the country.[114]

Sex-differentiated effects of exposure

Endocrine-disrupting chemicals impact both sexes but the exposure to the same chemicals may cause different effects in men and women. Endocrine-disrupting chemicals may for example have adverse effects on the female hypothalamic-pituitary-ovarian axis that regulates female reproductive hormones and female reproductive tissues. This in turn can lead to reproductive disorders such as early puberty, infertility, abnormal cyclicity, premature ovarian failure/menopause, endometriosis, fibroids, and adverse pregnancy outcomes.[115] There is a strong connection between pesticides and breast cancer rates in women, and almost 100 pesticides have been identified as potentially contributing to increased risk of breast cancer. Of these, 63% have been shown to have estrogenic effects in laboratory studies.[12]

A critical developmental window of susceptibility is during pregnancy when a series of sequential processes take place in the developing embryo and fetus. Exposure to EDCs during this time can lead to adverse birth outcomes and developmental effects, in some cases leading to irreversible, life-long impacts. For example, hormone-disrupting effects during the early stages of fetal development include developmental impacts on the central nervous system, skeleton, and reproductive system.

Increasing evidence indicates that the global rise in the rate of non-communicable diseases, including diseases and conditions related to the endocrine system such as preterm birth and low birth weight, or the early onset of breast development, is due to chemical exposure.[116]

Other effects on women from exposure to estrogenic EDCs include growth of fibroids in the uterus, ovarian dysfunction, and reduced fertility. Bisphenol A – the building block of polycarbonate plastics – is linked to reduced egg quality and viability in women seeking fertility treatment.[47] In the EU, a conservative estimate of the costs of female reproductive disorders attributable to EDCs is almost €1.5 billion annually, primarily due to fibroids and endometriosis.[117]

Since exposure to EDCs is so widespread, pregnant women are frequently exposed to multiple EDCs at the same time. For example, a Swedish study analyzing urine and serum samples from more than 2,300 pregnant women found 41 suspected EDCs above the level of detection in a majority of the samples.[118] A study in the US analyzed first trimester urine samples in 56 women and found that they in general were exposed to an average of 30 EDCs out of the 41 possible that were included in the analysis. These multiple exposures can lead to mixture effects in women and impact the pregnancy. The latter study found indications that the EDC mixture caused different effects on maternal inflammation than exposure to the individual EDCs.[119]

Gender-differentiated exposure

Similar to the other EPIs, gender aspects of exposures to EDCs involve occupation, consumer products, waste management, education, and socio-economic status. Since there is such a diverse range of chemicals with endocrine-disrupting properties, there are also a wide range of exposures. For women, occupational exposures include for example agriculture, manufacturing facilities, and service jobs. A case control study found that women in jobs with potentially high exposure to carcinogens and EDCs have an elevated breast cancer risk. These jobs included agriculture, automotive plastics manufacturing, food canning, and metalworking, with the risk of premenopausal breast cancer highest for automotive plastics and food canning.[120]

As discussed further below, women make up a large part of the agricultural workforce and have significant exposure to pesticides. Pesticides in wide use such as atrazine, 2,4-D, chlorpyrifos, and glyphosate are considered to be EDCs along with vector control agents such as DDT.[47] Another example is in plastics manufacturing where many EDCs are used. In Canada, the plastics industry has the highest proportion of women workers at 37% and in the US, almost 30% of workers in the industry are women. Studies have reported increased breast cancer risk in women working in plastics processing, rubber and plastics products production, and in occupations involving exposures to synthetic textile fibers.[121] A study of firefighters in Florida showed that female firefighters had significantly elevated risks of brain and thyroid cancers, whereas male firefighters were at increased risk of melanoma, prostate, testicular, thyroid and late-stage colon cancer.[122] In some regions of the world, women comprise more than 90% of the workforce in the field of nursing. A national study of nurses in China showed that 41% experienced menstrual disorders, most likely due to handling of disinfectants.[123]

Service jobs also expose women to EDCs. A range of studies of health effects and occupational exposure of nail salon workers, which are overwhelmingly women, have been conducted in the US, all showing that their work involves exposure to a number of toxic chemicals, including EDCs such as phthalates, formaldehyde, and toluene.[124] A study of the industry in California found 59% - 80% of nail salons are run by Vietnamese women, raising concerns about socio-cultural obstacles to worker safety, along with a sizeable proportion of women reporting health problems after they began working in the industry.[125] Similar results were reported from the East Coast.[126]

EDCs are widely present in products used by women including cosmetics, cleaning products, household pesticides, personal care products, and many consumer products.[47] Known or potential EDCs in these products include galaxolide, cyclic methyl siloxanes, parabens, phthalates, and metals.[22] Usually, these product ingredients are not disclosed as EDCs or potential EDCs. Exposure results directly from product use and/or release of the chemicals and settling into dust or carpets and subsequent ingestion.[47] Even when only a small number of EDCs are considered, they are present in a myriad of products.

Challenges and recommendations

Endocrine-disrupting chemicals are found in most sectors and products. They are also found to contaminate drinking water and food.[127] While countries are starting to take action on the most well-known EDCs such as Bisphenol A, it is important that more targeted activities and actions are implemented specifically to safeguard women's health.

Action can be taken on different levels from the individual, manufacturer and government levels. Governments can prioritize regulations that protect women from exposure to EDCs in food, consumer products and in the workplace, including mandatory assessment of EDC properties especially impacting women for chemicals. Such assessments could be coupled to setting tolerable daily intake levels for food and labeling requirements for products containing EDCs. Companies can inventory their products to identify and replace suspected EDCs with products for women as a first priority as well as assess and remedy any potential exposure of women workers in their production facilities. Awareness campaigns can be conducted to educate women and empower them to lower their exposure to EDCs by selecting products with low or no EDC content. Examples of tools existing today include:

- FREIA, an EU-funded project that aims to improve identification of chemicals that affect women's health via disruption of the hormone system.
- The Health and Environment Alliance (HEAL) has collected a range of information materials on EDCs relevant for women, including links to guidance from regulatory Agencies.*
- A recent book provides a thorough overview of everyday exposure to ECDs e.g. in our homes, our schools, at work and in our food, what their impacts are, and how to avoid exposure as far as possible.**
- The Skin Deep® database, a database of cosmetics ingredients made using ingredient labels and scientific and industry literature allowing consumers to search for EDCs and other chemicals in personal care products.

An emerging concern is the mixtures of EDCs since there is evidence of combination effects in women when the real-life exposure of mixtures of chemicals is assessed. There are indications that current regulatory approaches are underestimating these health risks and that options to amend these need to be assessed.[128] One approach proposed in the EU is to include an additional safety factor during regulatory risk assessment to account for these types of effects.

* http://env-health.org/IMG/pdf/20032015_paw__edcs_pesticides_and_pregnancy_final.pdf
** https://www.leotrasande.com/sicker-fatter-poorer

ENVIRONMENTALLY PERSISTENT PHARMACEUTICAL POLLUTANTS

The Emerging Policy Issue of Environmentally Persistent Pharmaceutical Pollutants (EPPPs) was adopted by government representatives at ICCM4 in 2015, recognizing the potential adverse effects on human health and the environment and the need to protect humans and ecosystems. It was also noted at the meeting that it is necessary to develop knowledge and raise awareness about potential effects from chronic exposure of pregnant women and children to low levels of such pollutants and to develop knowledge-based and coordinated action at the international level.[129] This issue was proposed and discussed already in 2011 at the SAICM Open-Ended (OEWG) working group meeting, but was postponed. Much evidence has emerged since about the widespread pollution of aquatic and terrestrial environments.[130]

Exposure and health effects

Pharmaceuticals can be released in the environment at any stage of their lifecycle, i.e. during production, use and disposal. Environmental releases have been reported from pharmaceutical production in many countries such as Canada, the US, Denmark, India, Vietnam and China with resulting elevated concentrations in surface water, groundwater and drinking water. In some of the places, extremely high concentrations have been detected in wastewater released from the manufacturing plants.[131] The most widespread source of contamination is the use of pharmaceuticals in human and veterinary medicine. While some degree of metabolism occurs in the body after application, a certain amount is excreted unchanged (ranging from 10-90% depending on the chemical properties of the drug). Therefore, a certain amount of the active substance will be excreted together with more or less active metabolites, enter the sewage system and finally end up in a sewage treatment plant (STP). A small contribution to the overall load into the sewage system is also unused drugs that are improperly disposed of. Hospital waste waters constitute a special case, where generally higher concentrations of pharmaceuticals are detected. Municipal STPs are not designed to remove antibiotics or other pharmaceuticals but to limit the release of nutrients and organic matter into the aquatic environment. Even so, some pharmaceuticals are removed during the treatment process due to adsorption, photolysis and bacterial degradation.[132] One of the most comprehensive studies measured pharmaceutical pollutants in 71 countries and found 631 different substances (or their metabolites) including antibiotics, non-steroidal anti-inflammatory drugs, analgesics, lipid-lowering drugs, estrogens, and others.[133] There are also direct sources of input into the environment such as livestock, fish farming and untreated release of wastewater.

Pharmaceuticals are designed to be bioactive compounds and as such, typically have an effect even at low concentrations. This means that exposure due to environmental contamination can cause unwanted effects. These effects have primarily been studied in an ecotoxicological context and the nomination of the EPI mentions a range of examples such as endocrine-disrupting effects of synthetic estrogens in fish, altered behavior of fish in response to exposure to antidepressants, and the kidney failure in vultures caused by the anti-inflammatory drug diclofenac.[134] One of the most well-studied pharmaceutical substances in the aquatic environment is 17α-ethinylestradiol (EE2), which is one of the most common synthetic estrogens used as an active substance in birth control pills. Other uses include hormone replacement therapies, counteracting deficits associated with menopause, hypoestrogenism, and the management of some pre- and postmenopausal symptoms. After ingestion, EE2 together with its metabolites estrone (E1) and estriol (E3), both with estrogen activity, are excreted and are frequently detected in sewage effluents and receiving waters. Estrogens are potent endocrine disruptors and can have adverse ecological effects in the environment, even at low levels, such as physiological alterations in gonads resulting in intersex, alterations in reproductive behavior, and adverse reproductive output.[135] A recent report from the OECD notes that 88% of human pharmaceuticals do not have comprehensive environmental toxicity data.[136]

Studies investigating the human health effects of EPPPs are still extremely limited. However, three overall concerns have been highlighted:

- The increase in antibiotic resistance and the role pharmaceutical pollutants have in increasing this process
- Endocrine-disrupting effects
- Mixture effects

One source of human exposure to pharmaceutical pollutants can be through drinking water. This can occur when pharmaceuticals contaminate surface waters such as lakes and rivers that are used as drinking water sources and there is insufficient treatment to remove these contaminants. While drinking water treatment plants are typically not designed to remove pharmaceuticals, in plants where chlorination and activated granular carbon treatment processes are already in place, these have been shown to reduce pharmaceutical contamination. However, the effectiveness is dependent on what types of pharmaceuticals are present in the water.[137]

There is only limited data available for tap/drinking water in developing and emerging countries and the majority of studies come from European countries such as Spain and Germany, where more than 30 different pharmaceuticals have been detected. Between 11 and 30 pharmaceutical substances have been found in tap/drinking water in Canada, China, France, Sweden, and the United States. Traces of pharmaceutical substances have also been detected in bottled water in France.[138] One study found nineteen pharmaceutical substances in the tap water of Shanghai[139], many of them at high concentrations, and another study detected nine pharmaceuticals in tap water in Malaysia.[140]

Exposure to pharmaceutical pollutants can also occur through food. Contaminants in water can be transferred up the food chain and contaminate fish and other seafood.[141] When wastewater and wastewater sludge is used to irrigate and fertilize fields in farming, this can lead to contamination of soil and food. Finally, when contaminated dung from animals that have been treated with veterinary pharmaceuticals is used as fertilizer, pharmaceuticals can be taken up by crops and also constitute a source of exposure.[142]

Improperly discarded pharmaceuticals can reenter food supplies when wastewater sludge is used to fertilize food crops.

Sex-differentiated effects of exposure

Pharmaceutical pollutants of concern include hormones, antibiotics, analgesics, antidepressants and anticancer pharmaceuticals. However, much information is still lacking when it comes to sex-differentiated exposure and effects. There was for many years a strong male bias in the development of new pharmaceuticals where clinical studies were conducted mostly with male participants and the results merely transferred to women, disregarding the physiological differences between women and men. This means that sex differences in effects of pharmaceuticals at all levels from gene expression to hormone systems and overall health were disregarded. There are for example instances where women have a higher susceptibility to adverse drug reactions, and hormones made by the ovaries are known to influence symptoms in human diseases ranging from multiple sclerosis to epilepsy. There is also a lack of comprehensive information about how many pharmaceuticals impact women during pregnancies, including the fetus during its highly vulnerable development stages.[143] Concerns that have been mentioned in relation to this issue include chemical exposures during development, exposures to chemical mixtures, chemical exposures in women of reproductive age, and the fact that some pharmaceutical pollutants are prohibited from prescription to pregnant women or children.

Gender-differentiated exposure

Certain types of pharmaceuticals are predominantly used in a gender-specific way such as contraceptives and treatment of erectile dysfunction. However, gender-differentiated exposure from environmental contamination is instead likely related to gender differences in division of labor. Very little information is available, and few studies have been conducted on this topic, but there are indications that environmental pollution from antibiotics accelerate antibiotic resistance and that this could be a concern especially for pregnant women. This could for example be the case with bacterial infections known to be transferred during birth and cause pregnancy-related concerns such as postpartum and neonatal diseases.[144] A special case is areas where pharmaceutical production has led to high environmental contamination, such as in Hyderabad in India. This area is a hub for the manufacture of generic drugs and extremely high levels of pharmaceuticals from the wastewater treatment effluents have been shown to contaminate the river, groundwater and well water in the area. A report about the situation in the area included stories of women having miscarriages, skin disorders, cancers, and intestinal problems.[145] It should be noted that there are no scientific studies investigating this further.

Challenges and recommendations

Pharmaceuticals in the environment has been a rapidly expanding research topic over the past decade. However, studies of associated health effects, as well as exposure data from developing countries and countries in transition, are still largely missing — as is research on gender-differentiated exposure. Clearly, there is an urgent need to rapidly increase the amount of information available and assess appropriate action, especially to protect women's health.

One of the knowledge gaps can be filled by assessing the hazard of the EPPPs that could potentially pose the highest risk for women, especially pregnant women, at very low concentrations. This includes the identification of those drugs that do not degrade, and therefore have the potential to accumulate in the environment, as well as metabolites that have equal or more toxicity than the parent compound. Other persistent pollutants such as the chemicals listed under the Stockholm Convention are known to be transported long-range through the atmosphere and by ocean currents and impact women in the Arctic. If there is potential for similar fates and effects of the EPPPs is currently unknown and needs to be further investigated.

Pharmaceutical production has been shown to be an issue of high concern, in some countries contributing to high levels of pharmaceutical contamination of drinking water. More information about the effects on women, and especially pregnant women, is needed since the few existing studies indicate the potential for concern. Another important action is to control conditions during production more closely. This could include labeling of origin to empower customers to avoid production sites of concern. Finally, before being placed on any market, pharmaceuticals need to be assessed for their environmental and health hazards, including the hazards for women, during their production.

PERFLUORINATED CHEMICALS AND THE TRANSITION TO SAFER ALTERNATIVES

Work on perfluorinated chemicals and the transition to safer alternatives as a SAICM Issue of Concern was initiated at ICCM2 in 2009 where stakeholders were invited to "*consider the development, facilitation and promotion in an open, transparent and inclusive manner of national and international stewardship programmes and regulatory approaches to reduce emissions and the content of relevant perfluorinated chemicals of concern in products and to work toward global elimination, where appropriate and technically feasible.*"[42] This was initially focused on OECD countries but the mandate was further broadened at ICCM3 in 2012 to also include non-OECD countries. The aim of the work is to gather and exchange information on perfluorinated chemicals and to support the transition to safer alternatives and has been coordinated by the Global Perfluorinated Chemicals Group. This group was established in 2012 in response to the SAICM resolution and brings together governments, industry, academia and NGOs from both developed and developing countries, organising webinars and publishing documents on risk management approaches and technical information.*

Per- and polyfluoroalkyl substances (PFASs) are a large group of more than 4,700 chemicals widely used in industrial and consumer applications

* https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/

since the 1940s. The acronym PFAS covers all fluorinated alkyl organic substances including perfluorinated, polyfluorinated, fluorotelomer and fluoropolymer compounds. Based on the length of the fluorinated carbon chain, short- and long-chain PFASs can be distinguished. PFAS not covered by the following definitions of long-chained are categorized as short-chained:

- Perfluorocarboxylic acids (PFCAs) with carbon chain lengths C8 and higher, including perfluorooctanoic acid (PFOA)
- Perfluoroalkane sulfonic acids (PFSAs) with carbon chain lengths C6 and higher, including perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonate (PFOS), and
- Precursors of these substances that may be produced or present in products.

In addition to the health effects described below, one key driver to phase out PFAS is the cost of remediation compared to replacement and prevention. One estimate of the societal costs for remediation of drinking water and groundwater in Europe alone has been calculated to be at least 10-20 billion Euros over 20 years. The cost estimated for remediation of only the town of Rastatt in Germany was found to be approximately 1-3 billion Euros.[146] A report published by the Nordic Council of Ministers on the cost of inaction for the European Economic Area (EEA), costs society will have to pay in the future, estimated annual health impact-related costs to 50-80 billion Euros. Environmental remediation costs for the EEA area plus Switzerland was estimated at a range of 821 million to 170 billion Euros, in total.[147]

Exposure and health effects

PFAS are used in a wide variety of consumer products including water and stain resistant clothing, lubricants, ski wax, carpet treatments, paints, cookware, cosmetics, photography, chrome plating, pharmaceuticals and firefighting foams. PFAS have also been widely used in food-contact materials such as non-stick cooking surfaces and food-contact papers such as pizza boxes, microwave popcorn bags, baking papers, and other paper wraps where the use of PFAS is meant to prevent the transfer of food grease to other surfaces. PFAS are also used in the production of polymers including fluoropolymers, like polytetrafluoroethylene (PTFE). Non-fluorinated alternatives are available for most of these uses.

Some PFAS compounds are restricted under the Stockholm Convention as Persistent Organic Pollutants, i.e. they:

- Remain intact for exceptionally long periods of time (many years)
- Become widely distributed throughout the environment as a result of natural processes involving soil, water and, most notably, air
- Accumulate in the fatty tissue of living organisms including humans, and are found at higher concentrations at higher levels in the food chain, and
- Are toxic to both humans and wildlife.

These include perfluorooctane sulfonic acid (PFOS) and its salts, perfluorooctane sulfonyl fluoride (PFOS-F), perfluorooctanoic acid (PFOA) and its salts, and PFOA-related compounds. The POPs Review Committee, the expert committee under the Convention, has also recommended listing perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds for global elimination without any exemptions.[148]

Evidence of strong concern is increasing also for the short-chain PFAS that are often used as regrettable replacements. These include perfluorobutanesulfonic acid (PFBS), perfluorodecanoic acid (PFDA), perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorododecanoic acid (PFDoA), perfluoroundecanoic acid (PFUnA), and perfluorotridecanoic acid (PFTrDA), among others. Not only do they exhibit similar toxicity profiles as the long-chained PFAS, they are extremely persistent and very mobile in the environment, leading to rapid spread of contamination. Their mobility has led the EU to include mobility as a criterion for identifying Substances of Very High Concern (SVHCs).[149]

Environmental contamination occurs throughout the life cycle of PFAS and products containing PFAS either intentionally or as impurities, such as manufacture, end use, recycling, waste management and sewage treatment. PFAS are therefore ubiquitous in surface water, deep-sea water, drinking water, waste-water treatment plants, leachates from landfills, sediment, groundwater, soil, the atmosphere, and dust. An important source of contamination of soil and groundwater is the use and disposal of firefighting foams, and they are prevalent in sediment and soil surrounding training centers and airfields in many countries around the world.

Drinking water and consumption of fish and other aquatic creatures caught in waterways contaminated with PFAS are acknowledged as an important source of human exposure to PFAS. In populations such as in the Arctic where PFAS are accumulating in biota and seafood and sea mam-

Firefighters have higher blood levels of PFAS compared to the general population due to exposure from PFAS-containing firefighting foam as well as PFAS-treated protective gear.

mals are traditional foods, food contamination is an especial concern. As products containing PFAS are utilized, even when used according to the manufacturer's instructions, PFAS substances are leached into foods and beverages. These chemicals are also detected in unpackaged foods due to bioaccumulation in meat and dairy products. PFAS are also regularly measured in household dust as they are shed and released from other consumer products and textiles.[150]

PFAS have long half-lives in the body. PFOA and PFOS have half-lives of 3-5 years in the human body, and PFHxS has the longest half-life in human serum ever reported for any PFAS with an average of 8.5 years. They bioaccumulate (i.e. build up in the body) and biomagnify – meaning that their concentrations are highest in the bodies of creatures at the top of the food chain, including humans. Human exposures to PFAS, including PFOA and PFOS and their replacements, have been documented in urine, serum, plasma, placenta, umbilical cord, breast milk, and fetal tissues.[151, 152] PFAS are today found in the blood of animals and humans worldwide.[153]

As PFOS and PFOA have been phased out of use or regulated by public health agencies, their concentrations reported in some human populations have begun to decline.[154] However, case studies continue to identify individuals and communities with higher exposures than the general population, including fire fighters, workers in PFAS manufacturing plants and downstream product manufacturing, people living in communities affected by PFAS contamination from these manufacturing sites or fire-fighting training activities, and individuals exposed through other occupational sources including medical workers and fishery employees.[155]

A large and growing number of health effects have been linked to PFAS exposure and evidence is mounting that effects occur even at background level exposures. Effects generally agreed on are liver damage, effects on lipid metabolism, increased serum cholesterol levels (related to hypertension), decreased immune response (higher risk of infection), increased risk of thyroid disease, decreased fertility, pregnancy-induced hypertension, pre-eclampsia, lower birth weight, and testicular and kidney cancer.[156]

Sex-differentiated effects of exposure

There are sex-differentiated effects resulting from exposure to PFAS, in addition to differences in bioaccumulation and clearance based on physiological differences between sexes. Several studies suggest that PFAS can mimic estrogen. In fish, exposure to PFHpA, PFOA, PFNA, PFDA or PFUnDA increases the expression of vitellogenin, a protein involved in the development of the egg.[157] In mice, exposures to PFOA increases the weight of the uterus, an effect that is also characteristic of estrogen exposures.[158] In another study utilizing human breast cancer cells, both PFOS and PFOA increased cell proliferation, consistent with estrogenic behavior.[159]

Sex-differentiated effects of PFAS exposure include effects during gestation and as infants mediated through breast milk. Mice exposed to PFOA during pregnancy developed problems with milk production and their daughters, exposed during gestation, had stunted mammary gland development.[160] Mice and rats exposed to PFOA or PFOS during gestation were typically smaller, with significantly reduced body weights observed at birth.[161] This effect has been observed also in humans.[162]

A substantial body of literature has examined the effects of PFAS exposures on hormone-sensitive outcomes in different human populations. One systematic review found some evidence for an association between PFOS, PFNA, or PFHxS and thyroid hormone function in specific life stages (mothers or their sons evaluated prior to puberty).[163] PFAS exposures were also associated with altered pubertal timing in children, measured by age at menarche in females and serum testosterone concentrations in males.[164] PFOA exposure has been shown to increase rates of menstrual cycle irregularities, and there is some evidence indicating that exposure to PFAS, even at low levels, may reduce fecundability.[165] Exposure to PFOS, PFOA and PFNA has also been shown to be associated with earlier natural menopause[166], which can be a risk factor for cardiovascular disease, neurologic disease, osteoporosis later in life.[167]

Gender-differentiated exposure

As with many other widespread contaminants, it is difficult to trace the exposure to specific sources. However, it is clear through biomonitoring studies of breastmilk that women globally are exposed to PFAS. Despite the long history and global spread of PFAS, studies have primarily been conducted in Asia, Europe, and North America, where it has widely been detected.[168] While data from developing countries and countries in transition is mostly lacking, PFAS has been found to contaminate breast milk in India, Indonesia, Jordan, Malaysia, and Vietnam. Levels detected in breast milk exceed drinking water health advisory levels and limits in some US states. A 2018 review of studies in Japan of a large cohort of pregnant women and their infants found that prenatal exposures to PFAS, such as PFOS and PFOA, may affect birth size, disrupt the homeostasis of several hormones, and affect the development of the nervous system, allergies, and infectious diseases.[169]

The most easily identified gender-differentiated exposure to PFAS is through consumer products predominantly used by either gender, such as cosmetics. According to the European Commission's database on cosmetic ingredients (CosIng), PFAS are primarily used as emulsifiers, antistatics, stabilizers, surfactants, film former, viscosity regulators and solvents.[*] Few studies of the PFAS content of cosmetics are available, and analytical data is very scarce.

A recent screening by the Danish Environmental Protection Agency based on ingredient declarations found a variety of fluoroalkyl substances and other fluorinated compounds in a broad range of cosmetic products. The most common products containing PFAS were foundations, Beauty Balm, Color Corrector cream, and other creams/lotions and powders. The report also concludes that these products typically have women as target groups. Eighteen of these products were selected for analytical testing, showing that 17 contained one or more PFAS substances. The highest concentration of a single substance was 3,340 ng/g PFHxA (perfluorohexanoic acid) found in a foundation, while the highest concentration of total PFAS (10,700 ng/g) was found in a concealer. These values should be compared

* https://ec.europa.eu/growth/tools-databases/cosing/

with the EU limit value of 25 ng/g.[170] A study of products on the Swedish market found that foundations and powders contained 25 different PFAS, with the most frequently detected being perfluorinated carboxylic acids (perfluoroheptanoic acid and perfluorohexanoic acid) and polyfluoroalkyl phosphate esters (PAPs). The analysis also detected presence of unknown organic and/or inorganic fluorinated substances, including polymers.[171]

Challenges and recommendations

PFAs are today contaminating most humans and environmental compartments and there is a clear need both for remediation of already existing environmental contamination as well as preventing further releases through replacing PFAS with safe, non-fluorinated alternatives. Since exposure is not generally gender specific besides PFAS in certain product groups, preventative measures will benefit both women and men. Overall measures needed to safeguard women's health include both voluntary and regulatory actions. A recent plan developed by Ministers of the Environment in the EU describes a path forward relevant for all countries and regions of the world.[146] Key actions include:

- Based on their similarities in toxicity and persistence, manage all PFAS as a group to avoid regrettable substitutions and take the likely mixture effects into account.
- Phase out all uses of PFAS as soon as possible, possibly with an allowed longer timeline for a few essential uses.
- Set strict limit values in all relevant regulations for PFAS, such as health-based limits in food and drinking water.
- Prohibit uses of PFAS that lead to direct exposure, such as in food contact materials, and ensure that effective monitoring and enforcement mechanisms are in place.
- Increase monitoring, awareness-raising, research on alternatives, remediation and environmentally sound management of waste.

These actions could be implemented with a priority on actions that would prevent exposure from the most significant sources for women. Health-based limits in food and drinking water for all types of PFAS need to be developed taking the sensitivity of pregnant women into account. Other actions with significant benefits for women's health include cleaning up drinking water and phasing out PFAS from food contact materials. It is especially important that PFAS are phased out from products such as cosmetics that are identified as exposure sources primarily for women. Dur-

ing the phase-out, product labeling and awareness-raising efforts about PFAS would empower women to make informed decisions and choose products free from PFAS.

HIGHLY HAZARDOUS PESTICIDES

Highly Hazardous Pesticides (HHPs) was adopted as an Issue of Concern at ICCM4 in 2015, where government representatives recognized that they cause adverse human health and environmental effects in many countries, particularly in low-income and middle-income countries. The decision included the encouragement to stakeholders to undertake efforts with an emphasis on promoting agroecologically-based alternatives and strengthening national capacity for conducting risk assessment and risk management.

Pesticide in this context is interpreted broadly as any substance, or mixture of substances, consisting of chemical or biological ingredients intended for repelling, destroying, or controlling any pest, or for regulating plant growth. No detailed specification of which pesticides should be considered highly hazardous was adopted at the meeting, but it was agreed that stakeholders should be guided by the definition contained in the International Code of Conduct on Pesticide Management adopted by the FAO Conference and recognized by the WHO Executive Board:

> *"Highly Hazardous Pesticides means pesticides that are acknowledged to present particularly high levels of acute or chronic*

hazards to health or environment according to internationally accepted classification systems such as WHO or Global Harmonized System (GHS) or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous".[172]

HHPs come from all major groups of synthetic pesticides: organochlorine pesticides, organophosphates, carbamates, neonicotinoids and phenylpyrazoles. However, not all pesticides in these groups are considered HHPs.

It was also agreed that stakeholders should be guided by the criteria for highly hazardous pesticides developed by the FAO/WHO Joint Meeting on Pesticide Management (JMPM) in 2008. According to this, HHPs should be defined as having one or more of the following characteristics:

- Pesticide formulations that meet the criteria of classes Ia or Ib of the WHO Recommended Classification of Pesticides by Hazard
- Pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)
- Pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)
- Pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)
- Pesticide active ingredients listed by the Stockholm Convention in its Annexes A and B, and those meeting all the criteria in paragraph 1 of annex D of the Convention
- Pesticide active ingredients and formulations listed by the Rotterdam Convention in its Annex III
- Pesticides listed under the Montreal Protocol, or
- Pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

There is no officially agreed list of substances that meet these criteria. The Pesticide Action Network (PAN) has developed its own guidance to support action on substances that meet the agreed definition and criteria. The PAN International List of Highly Hazardous Pesticides is a tool for identifying highly dangerous pesticides and actions to replace them with safer, agroecological and other appropriate non-chemical alternatives.[173]

Guidelines on Highly Hazardous Pesticides have been published by FAO and WHO under the International Code of Conduct on Pesticide Management. These Guidelines are designed to help pesticide regulators and other stakeholders to take action to reduce the hazards from HHPs. The guidance is based on a number of national initiatives that succeeded in identifying and replacing HHPs with less hazardous alternatives.[174] FAO and WHO have also published a brochure with easily accessible information about HHPs.[175]

The global use of pesticides has risen to more than 4 million metric tons per year (FAOSTAT, 2019). HHPs are considered to represent a fraction of all registered pesticides worldwide; in some cases as small as 6% (Southern African countries) while in other cases as high as 30% of the registered products.

Many of the HHPs sold to developing countries and countries in transition are often older generation substances that have been taken off the market in high-income countries (typically for their adverse health effects) and are therefore cheap. While they may be labeled with hazard statements and require Personal Protective Equipment (PPE), this is often too expensive, too uncomfortable to wear or of inadequate quality, leading to high human and environmental exposures.[172] A recent study showed for example that the largest pesticide manufacturers made on average 27% of sales income from HHPs in high-income countries; but for low- and middle-income countries the proportion rose to 45%. In their most important LMIC markets, Brazil and India, HHPs made up 49% and 59% of sales respectively.* A study of registered pesticides in six African countries showed that 9.5% were HHPs in Cameroon, 58% in Ethiopia, 34% in Kenya, 19% in Mozambique, 58% in Tanzania and 4% in Zambia.[176] In addition to adverse health effects, high trace levels of pesticides in food can be an obstacle for trade.

Exposure and health effects

Pesticides are designed to have an adverse biological effect on pests, which means that they are bioactive compounds. This means that there is a risk of adverse effects also in

* https://unearthed.greenpeace.org/2020/02/20/pesticides-croplife-hazardous-bayer-syngenta-health-bees/

Pesticides that can cause a range of health effects, including endocrine disruption, are commonly detected in blood, breast milk, and the umbilical cord blood of women working in agriculture.

non-target species, including a risk of adverse effects on human health and the environment. Pesticides represent some of the largest chemical exposures in developing countries and pesticide poisoning is a significant global public health problem.

A wide variety of acute (immediate) and chronic (long-term) exposure effects from highly hazardous pesticides have been demonstrated. Acute health effects can be local and/or systemic, such as respiratory, neurotoxic, cardiovascular, endocrine, gastrointestinal, nephrotoxic and allergic reactions.[177] Acute effects are often caused by higher levels of exposure that can occur during preparing, mixing or using pesticides. Other handling such as storage, cleaning and storage of application equipment, and disposal of empty containers and contaminated materials such as gloves can lead to acute health effects. These exposures include not only the primary handler of the pesticide but also bystanders, people entering treated fields, consumers eating treated produce too soon after application, etc. Many countries also have significant problems with the use of acutely toxic pesticides for self-harm purposes.

Chronic human toxicity refers to product properties that may cause any adverse effect as a result of repeated or long-term exposure. Chronic exposure to highly hazardous pesticides can result in effects on skin, eyes, nervous system, cardiovascular system, gastrointestinal tract, liver, kidneys, reproductive system, endocrine system and blood, and may also affect the immune system.[178] For example, organophosphate pesticides originate in the compounds developed in the 1930s as nerve agents. While used in modified version and at lower concentrations as insecticides, they are still toxic to non-target species, including humans. The most well-known organophosphate pesticide in use today is chlorpyrifos.[179]

Developing children are especially susceptible to exposure to hazardous pesticides and the effects can be lifelong and irreversible. For example, a review of available studies showed that prenatal and/or postnatal exposure to organophosphates such as chlorpyrifos had an effect on neurodevelopment in toddlers and preschool children, including adverse effects on mental and psychomotor development and an increase in attention deficit/hyperactivity disorders (ADHD).[180]

Exposure can also occur through pesticide residues in food. An EU report from 2018 showed that out of the 177 pesticides screened for, 42% of the foodstuff tested contained one or more pesticide residues in concentrations above the limit of quantification. Compared to the regulatory maximum residue level set for these pesticides, 4.5% exceeded this level.[181] Finally, exposure from residential use of pesticides is also common.

Environmental hazards of HHPs include contamination of water resources and soils e.g. through spray drift and runoff leading to toxicity to non-target organisms. This in turn can lead to disruption of ecosystem functions, such as pollination or natural pest suppression. For example, neonicotinoid insecticides have been identified as an important driver of the dramatic decline in bee diversity and abundance, which led to the 2018 ban in the EU for their use on open-field crops.[182]

Sex-differentiated effects of exposure

There are a vast number of studies from all regions of the world showing the presence of pesticide residues in the blood, breast milk and umbilical cord blood of women working in agriculture. Also, pesticide exposure from food and residential use of pesticides has been widely shown in women. There are a wide variety of adverse health effects from exposure to HHPs that are especially relevant for women, as shown in the examples provided below.

Many HHPs are potential endocrine-disrupting chemicals. One study concluded that about 650 of the approximately 800 pesticides in use today have the ability to affect the function of the endocrine system.[183]

Thyroid hormones are vital in vertebrates for normal development of the brain and a number of other organs such as inner ear, eye, heart, kidneys, bone and skeletal muscle. Therefore, fetal exposure to endocrine-disrupting chemicals can lead to lifelong impacts. Epidemiological data show that older types of pesticides such as the organochlorine, organophosphate and carbamate pesticides are often associated with thyroid hormone disruption. In addition, experimental data have shown both in vivo and in vitro that also newer classes of pesticides can disrupt thyroid hormone levels.[184]

Exposure to pesticides during pregnancy has been shown to cause several types of adverse outcomes. For example, exposure to organochlorine pesticides in pregnant women has been shown to lead to reproductive dysfunction, birth defects and and metabolic toxicity.[185] Also, high consumption of fruit and vegetables contaminated with pesticide residues has been shown to be associated with lower probabilities of clinical pregnancy and live birth per initiated cycle in infertility treatments, indicating that dietary pesticide exposure within the range of typical human exposure may be associated with adverse reproductive consequences.[186] One of many examples is a study from South Africa that found that women reporting miscarriages were more likely to have sprayed pesticides during pregnancy. In addition, the study found that women who reported death of their infants were more likely to have owned farms and worked longer in agriculture.[187]

A range of pesticides have been associated with the development of breast cancer, including atrazine, heptachlor, dieldrin, chlordane and malathion.[188] Female animal studies have suggested that pyrethroid exposure impaired ovarian function leading to symptoms of primary ovarian insufficiency (POI).[189]

Gender-differentiated exposure

The issue of women and chemicals in relation to pesticides and the broader topic of sustainable agriculture are both highly relevant, and gender is an important factor to consider in relation to use, exposure, health effects, and implications for food production. It has been estimated that women on average make up 40% of the agricultural labor force in developing countries. However, there is high variance between regions and big countries such as China and India impact both the Asian regional average and the global average. The sub-regional averages in Asia range from about 35% in South Asia to almost 50% in East and Southeast Asia. The large-country averages also obscure changes in smaller countries such as Bangladesh, where the female share of the agricultural labor force is now exceeding 50%. In Latin America, women make up about 20% of the agricultural workforce, whereas around 50% or more of the agricultural workforce in parts of Africa are women.[190]

Women may have a higher exposure to pesticides than men due to lower literacy, leading to limited ability to read warning labels and safety information, as well as limited access to training and to personal protective equipment compared to men. This problem has been reported from many countries in different regions, for example in Bolivia[191], China[192] and Mali[193], where higher pesticide exposure in women was shown to be coupled to higher illiteracy, lower awareness of the health hazards and lower awareness of the need to use appropriate personal protective equipment. Also, many farm workers do not read the labels but rather rely on information and advice received from pesticide suppliers, other workers and neighbors.[194] These may not know about or communicate about the risk to women from pesticides or how to effectively ensure protection from exposure.

However, data on gender aspects of pesticide use is both incomplete and inconsistent, the latter partly due to differences between countries in relation to cultural and social norms, educational levels and awareness. For example, a study from 2015 reported that South African women farmers were on average as responsible for spraying on their farms as men, that women carry out the bulk of spraying on oil palm plantations in Kalimantan, Indonesia, but that male farmers were much more likely to use pesticides in smallholder rice production in northern Ghana.[12] To more fully understand these dynamics, data needs to be drastically expanded.

Women are also uniquely exposed to pesticides even when they do not directly apply them. In Pakistan, where cotton is picked by women, a survey found that 100% of the women picking cotton 3-15 days after pesticides had been sprayed suffered acute pesticide poisoning symptoms.[195] Other routes of exposure to women not generally taken into account in exposure assessments include weeding and thinning sprayed crops, picking tea leaves, washing out the pesticide containers or washing pesticide-contaminated clothing. For example, one study from Kenya studied horticultural workers where women predominantly were responsible for planting, weeding, harvesting and/or pruning, whereas pesticide spraying was largely performed by men. Still, the women showed a higher frequency of pesticide poisoning.[196]

Challenges and recommendations

Highly hazardous pesticides are widely used in some countries and many women are exposed through agriculture work as well as through residues in food. The best protection for women's health is to accelerate the efforts to phase out HHPs.

Meanwhile, communication and awareness-raising efforts are a priority to educate the women in contact with them. Important issues to address include the hazard of HHPs, how to safely handle both HHPs and contaminated equipment, the risk of spray drift to nearby waterways and communities, and the risk of exposure when handling crops sprayed with pesticides. Appropriate personal protective equipment that is designed to fit women needs to be made accessible, for example by producers and retailers. Hazard labels need visuals that are easily understandable and communicate hazards, without requiring workers to read warning text.

As with many other of the EPIs, there is a significant lack of data in relation to HHPs, their impact on women, and effective measures to protect women's health. Important efforts include funding and supporting sex- and gender-differentiated studies on HHPs and their alternatives, and case studies about women in agriculture. In line with the guidance from FAO and the ICCM decision, special efforts should be made to support and raise awareness of agroecological approaches since these to a large extent are driven by women. In agricultural areas where pesticides are used, specific actions can be taken to support women in their roles as community leaders and agents of change. Capacity-building efforts that could be helpful include leadership and communication trainings, as well as specific training efforts about the need for appropriate protective equipment and other ways of minimizing the risk of exposure. This is especially important where information and advice about pesticide use is often shared orally through the community rather than through written communication.

There are additional general efforts that would highly benefit women. The recent evaluation of SAICM concludes that there is a need for SAICM stakeholders to increase their efforts of working in partnership to take action on highly hazardous pesticides and promote agroecology. This would minimize the adverse health impacts on susceptible groups such as women. A model for this collaboration proposed at ICCM4 was a Global Alliance to Eliminate Highly Hazardous Pesticides, building on the highly successful Global Alliance to Eliminate Lead Paint, providing a framework for collaboration of all stakeholders to phase out HHPs.

One of the obstacles to phasing out HHPs is simply that no internationally adopted list is available despite clear guidance from the FAO and ICCM on how to identify these. However, many pesticides that qualify as HHPs are already prohibited and phased out in some or many countries. Therefore, national action to identify and address HHPs could be supported by adopting such a list and raising awareness about the technical and economic feasibility of their alternatives. In addition, useful support includes tools and resources for countries to adopt effective national legal instruments prohibiting the import, export and use of HHPs.

Finally, international instruments could be strengthened and utilized to support and protect women from exposure to HHPs. These include e.g. the Stockholm and Rotterdam Conventions, the International Code of Conduct on Pesticide Management and the environmentally sound management and disposal of pesticide wastes under the Basel Convention.

4. THE NEXUS BETWEEN WOMEN AND CHEMICALS AND THE SDGs

The sound management of chemicals and waste is vital for sustainable development as acknowledged already at the establishment of the Strategic Approach to International Chemicals Management (SAICM), in the 2006 high-level Dubai Declaration:

> *"The sound management of chemicals is essential if we are to achieve sustainable development, including the eradication of poverty and disease, the improvement of human health and the environment and the elevation and maintenance of the standard of living in countries at all levels of development."*[1]

This link goes beyond the direct impact that exposure to hazardous chemicals can have on individuals. The 2030 Agenda for Sustainable Development was adopted as a path towards economic, social, and environmental development, including equality and poverty reduction. It is therefore important to consider the overall impact of hazardous chemicals on a country level such as impeding economic productivity and imposing costly additional burdens on a country's health and education systems. The inability of a country to safely manage chemicals can become a barrier that blocks economic development and poverty reduction, which are both essential to achieve the 2030 goals. For example, childhood lead exposure in developing countries and countries in transition, and the resulting loss of lifetime income, has been estimated to a total cost of $977 billion of international dollars, which was 1.2% of world GDP in 2011.[197]

As described in this report, without addressing gender issues in general and the special case of women and chemicals specifically, sound management of chemicals and waste cannot be achieved. As a result, the 2030 goals would not be achieved. Out of a total of 232 SDG indicators, 54 can be classified as gender indicators and 93 as environment indicators. However, only 8 targets and indicators can be defined as attempting to measure the interactions of environment and gender.[198] None of these refer to chemicals. Therefore, it is important to look more broadly at underlying factors for the SDGs and the efforts that need to be undertaken for these to be achieved beyond the targets and indicators.

This report focusses on the need to address issues related to women and chemicals as a step towards achieving the 2030 goals. Concrete actions for each of the SAICM EPIs that would safeguard women's health have been proposed above.

To illustrate the connections between the EPIs — both the actions needed to address women and chemicals, and the progress on relevant SDGs this will contribute to — we have provided examples below. Many SDGs are relevant for all EPIs, however only a few examples have been listed for each EPI.

Emerging Policy Issue	Example of action	Examples of SDGs and targets supported
Lead in Paint	• Identify exposure with highest impact on women and effective prevention methods • Adopt regulations that ban the manufacture, sale and import of lead paint	Goal 3: Good health and well-being Goal 11: Sustainable cities and communities Goal 12: Ensure sustainable consumption and production patterns
Chemicals in products	• Identify and control hazardous chemicals used in products with a priority for products for women • Ensure transparency of chemical content in products e.g. through labeling schemes	Goal 3: Good health and well-being Goal 12: Ensure sustainable consumption and production patterns Goal 16: Peace, justice and strong institutions
Hazardous substances within the life cycle of electrical and electronic products	• Phase out hazardous chemicals used in electronics with a priority on chemicals especially impacting women, and where not possible, prevent exposure through training and adequate protective equipment • Adopt policies that prevent pregnant women from working with hazardous chemicals	Goal 8: Sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation Goal 12: Ensure sustainable consumption and production patterns

Emerging Policy Issue	Example of action	Examples of SDGs and targets supported
Highly Hazardous Pesticides	• Train and support women in agroecological methods • Phase out HHPs with the highest impact on women	Goal 2: Promote sustainable agriculture Goal 3: Healthy lives and well-being Goal 15: Sustainable use of terrestrial ecosystems and halt of biodiversity loss
Nanotechnology and manufactured nanomaterials	• Support scientific studies on nanotechnology and women's health • Apply precaution and control use of nanoparticles in products used to a large extent by women such as cosmetics	Goal 3: Good health and well-being Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Endocrine-disrupting chemicals	• Assemble and raise awareness about a priority list of EDCs with high impact on women • Include gender considerations and EDCs in assessments of health guidance and product assessments	Goal 3: Good health and well-being Goal 4: Quality education Goal 16: Peace, justice and strong institutions
Environmentally persistent pharmaceutical pollutants	• Support scientific studies on EPPPs and women's health • Include gender considerations when assessing the hazards of EPPPs in the environment	Goal 3: Good health and well-being Goal 6: Clean water and sanitation Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Perfluorinated chemicals and the transition to safer alternatives	• Set strict limit values in all relevant regulations for PFAS, such as health-based limits in food and drinking water • Phase out all uses of PFAS as soon as possible, possibly with an allowed longer timeline for a few essential uses	Goal 6: Clean water and sanitation Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation Goal 12: Ensure sustainable consumption and production patterns

5. ADDITIONAL ACTIONS TO ADDRESS THE ISSUE OF WOMEN AND CHEMICALS

There are two complementary aspects of women and chemicals that need to be taken into account moving forward: the importance of women's equal participation in chemicals management as well as the need to prioritize the protection of women as a group highly susceptible to adverse effects from chemical exposure.

First of all, the link between sound management of chemicals and waste and gender, including the important aspect of women and chemicals, needs to be strengthened in the SAICM Beyond 2020 process. While both the SAICM Overarching Policy Strategy and the Dubai Declaration addressed the issue of women and chemicals, the Overall Orientation and Guidance for achieving the 2020 goal of sound management of chemicals does not mention either women or gender. Also, the independent SAICM evaluation only makes minimal reference to gender or women, and none of them in relation to equal participation by women or to gender equality.[199]

The following actions would help strengthen this aspect in the Beyond 2020 process:

- High-level recognition of the importance of addressing inequalities related to women and chemicals needs could be conveyed through Ministerial Declarations, high-level policy dialogue and other types of policy statements by Ministers of Environment, Health, Agriculture and Labour.

- Establish a multi-stakeholder women and chemical safety working group to develop recommendations for actions on women and chemical safety that are included in workplans guiding SAICM emerging policy issues and issues of concern.
- Consider Women and Chemicals as an Issue of Concern. This could both include the protection of women as a group highly susceptible to exposure to hazardous chemicals and inequalities in participation in decision making. In order to measure progress, it is important that this is accompanied by clear, quantifiable objectives, indicators and targets.
- Develop a Gender Action Plan to be implemented under SAICM Beyond 2020.

Further actions that can be considered in the Beyond 2020 process have been developed by the SAICM Secretariat[*], IPEN[**], Women Engage for a Common Future (WECF)[***], the MSP Institute[****] and HEJ Support.[*****]

Exposure to hazardous chemicals contribute significantly to the global burden of disease. It was estimated in 2016 that 1.6 million lives and 45 million disability-adjusted life-years were lost in 2016 due to exposures to selected chemicals.[200] Additional analysis of these statistics and the underlying causes is needed to highlight the integral role of women and chemicals in the sound management of chemicals and waste. The following actions could be considered:

- Develop an international report on the Cost of Inaction and the benefit of action with a focus on gender inequalities, women and chemicals and their implications for the sound management of chemicals and waste.
- Ensure that all aspects of the integrated approach to financing are fully implemented to ensure sound management of chemicals and waste and to protect women as an especially disadvantaged group
- Include women and chemicals as a funding priority issue in development of assistance cooperation in relation to SAICM and the sound management of chemicals and waste.

* http://www.saicm.org/Portals/12/Documents/SDGs/SAICM_Gender_Policy_Brief.pdf; www.saicm.org/Portals/12/documents/meetings/IP2/IP_2_6_gender_document.pdf

** https://ipen.org/toxic-priorities/women-and-chemicals

*** https://www.wecf.org/

**** https://msp-institute.org/projects/gender-chemicals

***** https://hej-support.org/saicm/

- Increase the amount and public availability of sex-disaggregated data on effects of chemicals and waste from all UN regions, in particular from developing countries and countries in transition.
- Include specific requirements for gender assessments, collection of sex-disaggregated data, and gender trainings for involved staff and project participants in project funding for chemical and waste.

Efforts are needed on all levels to achieve progress related to the issue of women and chemicals. Activities that could be undertaken include:

- Support inclusion of aspects related to both gender and women and chemicals in the process of developing and adopting national regulations related to chemicals and waste management, including the integration of the gender perspective in national occupational safety and health policies.
- Develop new or expand existing gender guidelines for all national projects relevant for the sound management of chemicals and waste to include the issue of women and chemicals in national development planning, priorities and processes.
- Develop and make available gender assessment tools that include women and chemicals and are applicable at the national and local levels. Accompany these tools with training and capacity building.

Finally, efforts are needed to ensure "women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life" as called for under SDG 5. Activities that could be undertaken include:

- Evaluate gender aspects of the participation in SAICM and in the Beyond 2020 process with a special focus on women. This includes both quantitative approaches such as number of women delegates and gender disaggregated data on e.g. speaking time at meetings, but also needs to include qualitative aspects such as the roles of participating women.
- To enhance women decision-making to make informed purchase decisions and safe use of products, it is important that industry make data and product information on chemical additives and associated health effects publicly available.
- Promote equal participation in decision-making at all levels and in all sectors related to chemicals. This includes policy-making at local, national, regional and international levels as well as all levels and decision-making groups in the private sector.

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SUSTAINABLE DEVELOPMENT GOALS